STRATEGIC STUDIES CENTER

SRI Project 2970 *January 1977*

Technical Note
SSC–TN–2970–8

IMPLICATIONS OF TECHNOLOGY TRANSFERS FOR THE USSR

By: DONALD W. GREEN HERBERT S. LEVINE

Prepared for:

DEFENSE ADVANCED RESEARCH PROJECTS AGENCY
1400 WILSON BOULEVARD
ARLINGTON, VIRGINIA 22209

CONTRACT MDA903–74–C–0165
ARPA Order No. 2585

STANFORD RESEARCH INSTITUTE
Menlo Park, California 94025 · U.S.A.

STANFORD RESEARCH INSTITUTE

STRATEGIC STUDIES CENTER

Report Categories:

The research output by the Strategic Studies Center is published in four formats:

1. Research Memorandum (RM) and Final Report: Research Memoranda and Final Reports are documents that present the results of work directed toward specific research objectives. The reports present the background, objectives, scope, summary, and conclusions of the research as well as the general methodology employed. The reports are previewed and approved by the Director of the Strategic Studies Center or higher official of the Institute and constitute satisfaction of contractual obligations.

2. Technical Note (TN): Technical Notes may be of two types:

   a. Reports which satisfy contractual obligations. When a TN is used for this purpose it presents final research findings relating to a specific research objective. It differs from the RM or Final Report only in that for contractual convenience it has been reproduced and bound in SSC grey covers rather than formally edited, printed, and bound in standard SRI covers. The reports are reviewed and approved by the Director of the Strategic Studies Center or higher official of the Institute.

   b. Reports that present the results of research related to a single phase or factor of a research problem or are a draft RM or Final Report. In this format the purpose of the TN is to instigate discussion and criticism of the material contained in the report. The reports are approved for 'review distribution' by the Director of the Strategic Studies Center.

3. Informal Note (IN): An Informal Note is an informal working paper containing initial research results or specific findings on a particular subtask of a study. The IN is designed to record and control the input to the various studies at an earlier stage of the report process than a Technical Note. This class of paper is designed primarily to replace the use of internal SRI memoranda in communicating with the client or in obtaining staff comments. All data submission to the client that are not TNs or RMs are submitted as Informal Notes. The note is reviewed and approved by the Director of the Strategic Studies Center and is not used to satisfy contractual obligations.

4. Symposium Paper (SP): A Symposium Paper is a document presented as part of, or a record of, symposia held at SRI or may be a document written by an employee of SRI for symposia attended elsewhere. The report is reviewed and approved by the Director of the Strategic Studies Center or higher official of the Institute. If appropriate, Symposium Papers would be used to satisfy contractual obligations.

STANFORD RESEARCH INSTITUTE
SRI-Washington D.C. Office · U.S.A.

STRATEGIC STUDIES CENTER

SRI Project 2970 *January 1977*

Technical Note
SSC–TN–2970–8

IMPLICATIONS OF TECHNOLOGY TRANSFERS FOR THE USSR

By: DONALD W. GREEN HERBERT S. LEVINE

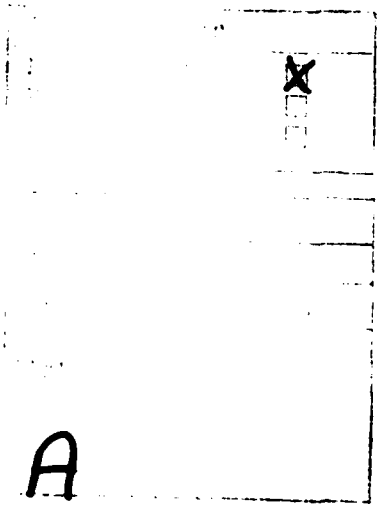
Prepared for:

DEFENSE ADVANCED RESEARCH PROJECTS AGENCY
1400 WILSON BOULEVARD
ARLINGTON, VIRGINIA 22209

CONTRACT MDA903–74–C–0165
ARPA Order No. 2585

~~Approved for Review Distribution~~:

Richard B. Foster, Director
Strategic Studies Center



This Technical Note is a draft final report and contains the findings relating to a specific set of research questions. Accordingly, it may be expected that the document will be revised, as appropriate, upon completion of the review process. The document does not constitute an official report of Stanford Research Institute until published in final form.

Executive Summary

History and Problems of Technology Absorption in Russia

The Soviet Union is currently in a period of rather intense importation of advanced technology from the developed industrial countries. This is not the first time in Russian history that such importing of technology has occurred.

The transfer of advanced foreign technology into Russia on a massive scale actually occurred as early as the beginning of the 18th century, during the reign of Peter the Great. Peter brought in not only foreign technology, but foreign technologists by the thousands, and built an economic base for the support of his military and foreign policy ambitions.

Within the past hundred years of Russian history there have been two major periods of concentrated effort to acquire advanced foreign technology. The first of these was connected with the industrialization spurt in the 1890s. As a result of this foreign investment, not only was the capital stock of Russia greatly expanded, but also foreign technology was brought into Russia, both in the form of advanced capital equipment itself and in the form of human capital. Foreign technologists, experienced businessmen, managers and engineers came to Russia as foreign companies were set up within Russia. Direct foreign investment was thus responsible for the implantation of advanced techniques in several key industries. Moreover, the foreign firms competed with Russian firms inside Russia and forced the latter to be more efficient if they were to survive.

A second period of major importation of foreign technology occurred during the 1920s and, especially, the early 1930s. During the relatively free market-oriented period of the New Economic Policy of the 1920s, the Soviets attempted to import foreign technology through the program of foreign concessions. It was during the period of the First Five Year Plan,

1928 to 1932, that major efforts were made to import foreign technology to carry out Stalin's ambitious program of rapid industrialization. With the emphasis on industrial capital formation, imports of machinery and equipment began to assume greater importance. By 1933 the imports of machinery and equipment rose to a level of more than half of the total imports of the Soviet Union. On the whole, imports of capital goods from abroad amounted to almost 15 percent of gross investment in the Soviet Union during this period. Furthermore, imports of certain basic industrial materials--lead, tin, nickel, zinc, aluminum, rubber--accounted for perhaps 90 to 100 percent of these materials consumed in the Soviet industrialization program.

In the next five year plan period, 1933-37, imports of foreign capital goods fell to about 2 percent of gross investment. Dependence upon the West for major products decreased dramatically.

Intense periods of rapid economic growth, during which Russia attempts to catch up with the advanced nations of the West, are followed by periods of withdrawal and relative stagnation. When the military needs of the State were pressing, the economy was pressured by the State into rapid growth; when a degree of power parity was reached with the West, the need for rapid growth subsided and the State removed its pressure for growth. As a consequence, a period of rapid growth was followed by a period of little or no growth.

In the past periods of importation of advanced technology, the Russians were able, within a compressed period of time, to approach contemporary economic development levels in the West and, to some extent, even the levels of contemporary technology in the West. Yet in the longer run, as the advanced nations of the West continued to develop new technology, the Russians were not able to maintain their relative position, and they fell back.

Among the Soviet economic institutions which affect the ability of the economy to absorb, master, and create new technology are:

(1) The managerial incentive mechanism that has more or less dominated the Soviet scene since the 1930s. Innovation always involves risk.

The compensation for risk is reduced by the fact that success today will mean a higher target tomorrow, and success in the system requires the regular meeting of targets. Thus, managers resist innovation and try to keep targets low. There is much discussion in the Soviet Union on how to get around this problem, but nothing very effective has been introduced so far.

(2) The organization of research and development (R&D). Considerable expenditure is devoted to R&D in the Soviet Union, but to a great extent it is separated from the production process, and less attention is paid to development than research. As a result, while new technology is generated and foreign research studied, the implementation and diffusion of such technologies are limited. One of the reforms currently underway, the creation of large "scientific production associations," offers the promise of bringing the Soviet organizational relationship between research, development, and production more into line with the pattern dominant in the West.

(3) The technology transfer process is primarily a people-process. Technology is best transferred from firm to firm and from country to country by people (managers, engineers, sales engineers, etc.) rather than by publications (including blueprints) or products themselves. In the postwar period, the Soviets have concentrated on the latter approaches while making minimal use of the former. Currently, however, they appear to be paying more attention to the people part of the process.

The elements discussed so far have related to Soviet institutions and practices, but the Russians under the Tsars also had trouble mastering modern technology and maintaining its dynamic change. The common elements in the pre and post-revolutionary Russian scene which may explain these difficulties are:

(1) The creative destruction aspect of technical change--that is, when something new is done and it is successful, the old is destroyed. In a politicized, bureaucratic economy, as was the case under both Tsars and Bolsheviks, those who operate existing activities and technologies are much better able to protect themselves against the threat of new activities and technologies.

(2) The absence of a threat of bankruptcy in the non-competitive Soviet economy has an impact because the innovational process responds in a positive way to high rewards for successful innovation and it also responds to the fear of being driven out of business by dynamic competitors.

(3) The Soviets have primarily imported foreign technology for domestic purposes rather than for exports which would have to be internationally competitive. Thus, once the new technology was in place, there was no pressure on those using it to keep it up to changing foreign levels, and the technology languished.

Econometric Analysis of the Role of Technology Transfer in Soviet Industrial Growth, 1968-80

As was stated above, while both Western observers and current Soviet policy-makers appear convinced of the contribution of foreign technology to Soviet industrial growth, the quantitative significance of the technology transfer remains a major unanswered question.

During the construction of the SRI-WEFA Econometric Model of the Soviet Union, a new methodology was developed for evaluating the quantitative impact of imported machinery on Soviet industrial production. This methodology, to a certain extent, provides a measure of the gains from technology transfer. The incorporation of this feature within the complete macroeconometric model provides a framework for evaluating the direct and indirect benefits of Soviet machinery imports through counterfactual scenarios in the past and conditional projections into the future.

In the analysis reported here, SOVMOD II, the second-generation version of the SRI-WEFA Soviet Econometric Model was used.

The gains from international technology transfer will depend upon the technical gap between nations and the absorptive efficiency of the receiving nation (its capacity for learning and absorption). In an attempt to quantify the gains from technology transfer, there are clear advantages to focussing on imported machinery and equipment. Machines imported from nations more technologically advanced can increase a domestic production in three different ways:

(1) directly through higher productivity in domestic production;

(2) indirectly through use in the production of more efficient domestic machinery; or

(3) even more indirectly through the transmission of information which results in a higher domestic level of technology.

The value of information embodied in foreign machines will rarely be fully captured by the price of the product.

In order to estimate the contribution of imported machinery to Soviet industrial production, a measure of foreign capital from Soviet import data was constructed and that measure was used to disaggregate the capital stock into foreign and domestic categories.

Over the period 1960-73, there are some important patterns in the growth of foreign capital in Soviet industry, as shown in Table 1. Using the disaggregated series of foreign and domestic capital stock, a production function with three factors of production--labor, foreign capital and domestic capital--was estimated. It is assumed that each imported machine carries potential information which may raise the level of Soviet technology. Given a constant expenditure of internalization effort (analysis and diffusion) per unit of imported machinery, the level of domestic technique will depend upon current and past levels of machinery imports. When one estimates the "contribution" to output of the marginal foreign machine, there are two components to the marginal productivity: (1) a direct measure of productivity, and (2) its contribution to the productivity of domestically produced machinery. If this "learning" component is significant than the marginal productivity of foreign capital estimated in a production function ought to be higher than what one might judge reasonable for direct productivity relative to domestic capital, and that is exactly what our econometric results suggest.

In the Soviet macromodel, efforts have been made to specify the pattern of bureaucratic behavior (rule of thumb), identify contingencies to which such bureaucratic rules must respond, and clarify where possible the role of

TABLE 1

Rates of Growth of Foreign Capital, 1961-1973

Year	Aggregate Industry	Chemicals and Petrochemicals	Machine-Building & Metal-Working	Petroleum Products
1961	5.2	19.8	9.6	16.9
1962	6.7	15.4	9.8	27.0
1963	7.9	7.3	11.2	31.4
1964	6.2	11.1	10.3	27.4
1965	4.1	8.3	10.7	25.9
1966	2.5	6.9	7.3	21.5
1967	3.4	9.7	5.3	10.9
1968	6.7	10.8	6.2	11.8
1969	10.0	10.9	8.8	13.6
1970	11.6	5.5	7.8	10.2
1971	8.0	0.4	21.6	7.5
1972	7.1	3.4	6.8	8.4
1973		10.0	10.8	5.1
Mean Growth Rate 1961-1972	6.6	9.1	9.6	17.7

administrative intervention in shifting the rule from epoch to epoch. The "rule of thumb" in this hypothesis is that real foreign machinery is allocated proportionately to the allocation of domestic investment over time within any given category of investment.

In Figure 1 below, the general historical pattern in the observed import/investment ratios is indicated. Over the sample period 1961-1973, the equilibrium ratio is shifted upward with detente with shortrun variation "explained" in part by the liquidity measure. The retardation in real machinery imports in the mid-1960s is due first to the restriction in industrial investment and second to the decline in Soviet hard currency liquidity after the 1963 harvest failure. Several different projection patterns are indicated for the period 1974-1980: projection (a) continues the upward trend observed in the period of detente; projection (b) continues the detente shift but abandons the upward trend; and projection (c) represents a combination of projection (a) with declining Soviet liquidity because of grain purchases in 1975-1976.

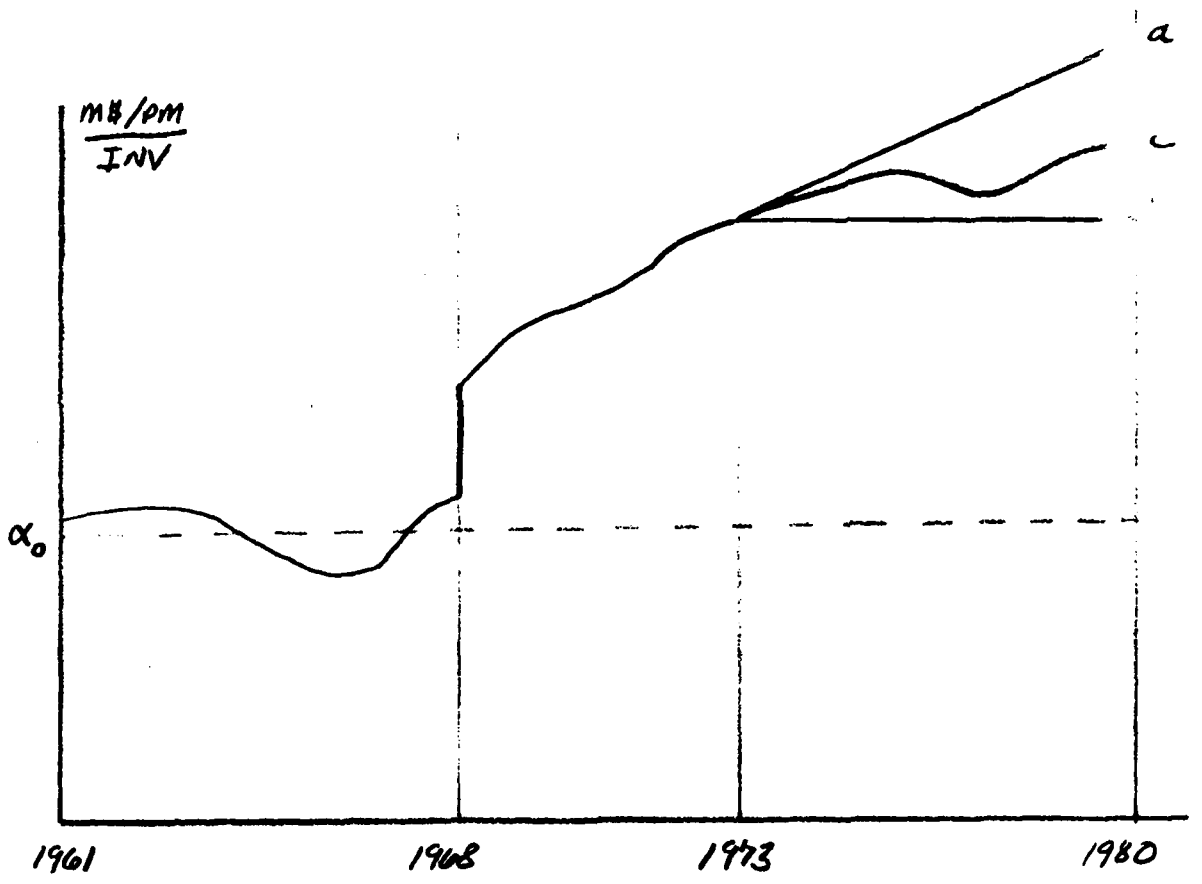
How might Soviet development have been different had those shifts in Soviet machinery demand not taken place? By retrospectively repealing 'detente' consequences for East-West trade, a measurement of Soviet gains from machinery imports is obtained holding historical environment constant, i.e., financing of investment, defense expenditure, weather, the world economy, etc.

Scenario I: A Retrospective Repeal of Detente, 1968-1973

In scenario analysis, a control solution as a standard of reference of counterfactual experiments is constructed. For the control solution, the model is solved dynamically from 1968 to 1973 using actual historical values for all variables in the period of solution. Once the control solution is determined, a No-Detente scenario is computed. Only the machinery import component of the model is adjusted. Industrial investment and capital formation are unchanged; only the foreign/domestic composition of industrial

FIGURE 1

Historical Pattern of the Import/Investment Ratio



capital stock is different with consequences for industrial production. The decline in Soviet imports results in an increase in Soviet hard currency liquidity which acts to boost machinery imports in the following year. The hard currency liquidity gain also lessens next year's exports to the Developed West which in turn lowers the liquidity position in the year after that. The shift in capital composition also generates another systemic process through the employment loop. A reduction in the growth of average labor productivity in industry lowers the growth of the real industrial wage. This reduces subsequent growth in industrial employment through participation effects and, with a longer lag, through a rural/urban migration effect.

In comparing our Scenario with the control solution, the full system impacts of the detente effect on Soviet machinery imports is observed. Table 2 presents several measures which indicate the magnitude of this detente effect. The model suggests that the growth of industrial production from 1968 to 1973 would have been only 28.4% without those additional imports of Western machinery, i.e., approximately 15% of the growth rate in the control solution (33.7%) would have been foregone. In this version of the model with no compensatory policy shifts, nearly the full impact of this loss in GNP falls upon consumers. At the end of the period, the USSR has a stronger hard currency position with $1.2 billion additional reserves in the No-Detente Scenario with a slower expansion in foreign trade turnover.

Scenario II: The Projected Benefits of Imported Machinery for Soviet Industrial Growth, 1973-1980

The situation of the Soviet economy in the mid-1970s is somewhat different from that of the mid-1960s, in part because of the substantial imports of Western machinery during the period 1968-74. To increase our understanding of the quantitative contribution of technology transfer, projective scenarios with 10 percent upward and downward shifts in Soviet demand for foreign machinery were constructed. For projective analysis, the derivation of a control solution is considerably more difficult than for retrospective analysis because of uncertainty concerning the paths of exogenous variables.

TABLE 2

The Impact of Détente: Main Indicators

Indicator	Détente Control	No Détente Scenario
	Percentage Growth, 1968-1973	
Gross National Product	30.3	27.7
Industrial Production	33.7	28.4
Chemicals & Petrochemicals	33.9	26.6
Machine-Building	42.6	40.8
Foreign Trade Turnover	57.9	52.9
Aggregate Consumption	26.0	21.9
	Value in 1973	
Imported Western Machinery (B. 1955 Rubles)	10.14	8.27
Hard Currency Reserves (M. Current $)	-318.	878.

For these scenario exercises, a control solution was prepared for an extended analysis of the Tenth Five Year Plan. The version of SOVMOD II used is the same as that for Scenario I (with the "detente" effects restored).

The main indicators of the control solution are compared with the Tenth Five Year Plan in Table 3 below. In general, the aggregate output targets of the Plan appear to be feasible by the standards of SOVMOD II. However, our projection anticipates more growth in employment and capital investment and fewer gains from technical progress than called for in the Plan.

Around this control path two scenarios were constructed by shifting Soviet demand functions for foreign machinery. In Scenario II-A all features of the control solution are maintained except each machinery demand function is increased by 10 percent. In Scenario II-B, those parameters are reduced by 10 percent. Consequently, impact multipliers in both directions for imported machinery can be calculated. The broad features of these scenarios are presented in Table 4. The upward impact multiplier for Scenario II-A is 12.1 while the downward impact multiplier for Scenario II-B is 12.4 for 1973-78. Two important observations derive from these experiments. First, the multipliers for Western machinery are lower for the USSR in the 1970s than they were at the end of the 1960s, though they are still large. With the more rapid accumulation of Western machinery relative to domestic capital in the period of detente, the return on the imported capital have declined relative to the domestic capital from the sample-period level. Second, the multiplier downward is greater than the multiplier upward for the same reason.

Conclusions

There appears to be an apparent contradiction between the qualitative impression of Soviet difficulties with the absorption of advanced technology at the microeconomic level and the quantitative estimates of the impact of imported Western machinery at the macroeconomic level, derived from the SRI-WEFA Soviet econometric model. The results appear to show a greater payoff to the importation of foreign technology than might have been assumed from the qualitative-analytical and anecdotal literature (both Western and Soviet) on the Soviet economy.

Table 3

MAIN INDICATORS OF THE NINTH AND TENTH FIVE-YEAR PLANS

Ninth Five-Year Plan Period, 1971-75

Indicator: Rates of Growth	(1) Official Plan Target	(2) Official Claim	(3) SOVMOD II Control
GNP	-	-	26.0%*
National income	38.6%	28.0%	-
Industrial output	47.0%	43.0%	43.0% (34.)†
Industrial labor productivity	39.0%	34.0%	32.4% (24.1)†
Industrial employment	5.9%	6.7%	8.0%
Agricultural output (5-year average)	21.7%	13.0%	12.0% (10.)†
Real income per capita	31.0%	24.0%	21.8%
New capital investment	41.6%	-	40.8%
Total consumption	-	-	24.0%
Foreign trade turnover	33.-35.%	-	54.0%

Tenth Five-Year Plan Period, 1976-80

Indicator: Rates of Growth	(2) Preliminary Plan Target	(3) SOVMOD II Control
GNP	-	23.8%*
National income	24.-28.%	-
Industrial output	35.-39.%	40.6% (31.8)†
Industrial labor productivity	30.-34.%	32.4% (24.1)†
Industrial employment	4.2%	6.2%
Agricultural output (5-year average)	14.-17.%	11.2% (9.2)†
Real income per capita	20.-22.%	16.6%
New capital investment (5-year total)	24.-26.%	30.0%
Total consumption	-	23.6%
Foreign trade turnover	30.-35.%	25.0%

* Since 1975 GNP is depressed because of the poor harvest, a Five-Year Moving Average (1973-77) of the Control Solution was used in comparisons with 1970 and 1980.

† Model projections on Western data basis (in parentheses) converted to Soviet data basis using simple adjustment factors observed 1966-70.

Sources: (1) N. K. Baybakov (General Ed.), Gosudarstvennyy pyatilentniy plan razvitiya narodnogo khozyaystva SSSR na 1971-1975 gody, Moscow, 1972.
(2) Pravda, 15 December 1975.
(3) SOVMOD II Control: 9 March 1976.

Table 4

CONTROL SOLUTION AND DEMAND-SHIFT SCENARIOS, 1973-80

Indicator	Scenario II-B 10% Decrease	Control Solution	Scenario II-A 10% Increase
		1975-80 Growth	
Gross national product*	23.5%	24.0%	24.6%
Industrial production†	39.5 (30.8)%	40.6 (31.8)%	41.7 (32.8)%
Petroleum products	42.5 (36.6)%	43.4 (37.5)%	44.4 (38.5)%
Chemicals & petrochemicals	52.5 (31.3)%	55.0 (33.5)%	57.4 (35.5)%
Machine building	53.6 (32.7)%	54.5 (33.5)%	55.0 (33.9)%
		1980 Value (Billion 1955 Rubles)	
Stock of imported machinery			
Aggregate industry	18.41	19.57	20.72
Petroleum products	3.18	3.37	3.57
Chemicals & petrochemicals	3.45	3.67	3.88
Machine building	3.46	3.66	3.85

* Five-Year Moving Average for 1975.

† Western sample indexes for Soviet industrial output are in parentheses. These growth projections are converted to Official Soviet statistics using adjustment factors determined for 1966-70.

A number of methodological problems in calculating Soviet gains from technology transfers come into focus when the process of technology transfer is considered more carefully. Two of the major ones are omitted costs and returns to scale in the technology transfer process.

In this study the reported Soviet expenditure on imports of Western machinery is related to the derived increments of industrial output. However, the process of technology transfer involves additional expenditures of domestic resources (particularly skilled manpower) as well as supplementary payments for technical assistance from abroad. Unfortunately, these expenditures at the aggregate level, at least those involving domestic resources cannot be observed.

To refine the estimates of the contribution of imported machinery, quantitative measures of the supplementary expenditures need to be derived. For example, a sample of transfer projects could be evaluated to determine a ratio of domestic resource expenditure to external expenditures on physical machinery and equipment. If one were to adopt the common "rule of thumb" of three rubles internal expenditure for each ruble of external expenditure, the impact multipliers would be reduced by a factor of four (from 12-15 to 3-4). This issue bears particularly on the "reasonableness" of the no-detente scenario (Scenario I). One would expect that a reduction in the scale of imports would release domestic technology "transfer" resources to the factory floor, with a consequent increase in production from the Scenario I path. However, in principle at least, this potential reallocation of factors within aggregate industry should already be taken into account by the econometric estimation over the sample period.

A second problem involves the important issue of scale in technology transfer. One may think of a continuum of technology transfer projects ranked according to an effectiveness criterion (a Soviet rate-of-return). Such a continuum of potential projects will exist in each time period. If the scale of aggregate technology transfer, as measured by the level of machinery imports, is increased than one assumes that projects of lower

productivity will be undertaken. Similarly, if the scale of technology transfer is reduced, the effectiveness of the marginal product should rise. In future research the econometric model should be adjusted to more effectively measure the impact of scale on technology of transfer.

ABSTRACT

This Technical Note attempts to provide a quantitative measure of the economic gains that have accrued to the Soviet Union from technology transfer.

The paper begins by tracing the history of Tsarist Russia and the Soviet Union in importation, absorption and mastering of foreign technology. The econometric model developed by SRI-WEFA is then employed to develop a measure of the benefits to technology transfer for the recent past (1968-1973) and to estimate the prospective gains in the near future (1975-1980).

FOREWORD

This Technical Note represents an application study of the SRI-WEFA Econometric Model of the Soviet Union, undertaken during the third phase of development work on the model funded by ARPA. This application study represents a component of the SRI continuing program in Soviet Comparative Economic Studies. The program is directed by Dr. Herbert S. Levine, Senior Research Consultant at the SSC and Professor of Economics at the University of Pennsylvania, and M. Mark Earle, Jr., Senior Economist and Assistant Director of the SSC.

This study was prepared by Dr. Donald W. Green, Research Consultant, SSC, and Dr. Herbert S. Levine. An earlier draft of this paper was presented at the Eastern Economic Association in April 1976, and appeared in draft form as Soviet Econometric Model Working Paper No. 42.

Richard B. Foster
Director

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

I BACKGROUND

A. Outline of Paper

In Western analyses of the Soviet economy, it is common to talk of the benefits which have accrued to the Soviet economy from the importation of advanced foreign technology, while at the same time speaking of the difficulties the Soviets have had in absorbing advanced technology and in mastering the process of technical change. It is rare, however, that an attempt is made to provide a quantitative measure of the gains the Soviets actually have made from technology transfer. This paper attempts to develop such a measure.

In the remainder of Part I, past efforts in Tsarist and Soviet history to import foreign technology, and the reasons for Russian difficulties in absorbing and mastering advanced technology are discussed. In Part II the Soviet Econometric Model, constructed under the joint Stanford Research Institute (SRI) and Wharton Econometric Forecasting Associates (WEFA) program, is employed to develop a measure of Soviet gains from technology transfer in the recent past (1968-73) and to estimate the prospective gains in the near future (1975-80).

B. History and Problems of Technology Absorption in Russia

The Soviet Union is currently in a period of rather intense importation of advanced technology from the developed industrial countries. This is not the first time in Russian history that such importing of technology has occurred.

The transfer of advanced foreign technology into Russia on a massive scale actually occurred as early as the beginning of the 18th century, during the reign of Peter the Great. Peter brought in not only foreign

technology but foreign technologists by the thousands, and built an economic base for the support of his military and foreign policy ambitions.

Within the past hundred years of Russian history there have been two major periods of concentrated effort to acquire advanced foreign technology. The first of these was connected with the industrialization spurt in the 1890s. It was led by the Russian minister of finance, Count Witte, whose policy was to encourage foreign investment in Russia. Foreign capital, especially French and Belgian, accounted for almost 50 percent of all new capital investment in Russia during the industrialization drive of the 1890s. In 1900, foreign companies owned more then 70 percent of the capital in mining, metallurgy and machinebuilding in Russia.

As a result of this foreign investment, not only was the capital stock of Russia greatly expanded, but also foreign technology was brought into Russia, both in the form of advanced capital equipment itself and in the form of human capital. Foreign technologists, experienced businessmen, managers and engineers came to Russia as foreign companies were set up within Russia. Direct foreign investment was thus responsible for the implantation of advanced techniques in several key industries. New technology was often incorporated with little or no adaptation. For example, the steel mills built in southern Russia after the mid-1800s were of the same technological level and size as those being built in Western Europe. In this period, with the continuing participation of foreigners in management, these steel mills kept up with West European progress and Russia remained in the mainstream of world progress in steel making. Moreover, the foreign firms competed with Russian firms inside Russia and forced the latter to be more efficient if they were to survive.

A second period of major importation of foreign technology occurred during the 1920s and, especially, the early 1930s. During the relatively free market-oriented period of the New Economic Policy of the 1920s, the Soviets attempted to import foreign technology through the program of foreign concessions. The quantitative importance of this program is a

matter of debate. Nevertheless, the actual number of business arrangements with foreign concerns was larger than has been commonly believed.[1] However, it was during the period of the first five year plan, 1928 to 1932, that major efforts were made to import foreign technology to carry out Stalin's ambitious program of rapid industrialization.[2] With the emphasis on industrial capital formation, imports of machinery and equipment began to assume greater importance. By 1933 the imports of machinery and equipment rose to a level of more than half of the total imports of the Soviet Union, and imports of certain types of machines--turbines, generators, boilers, machine tools, metalcutting machines--accounted for between 50 and 90 percent of the growth in the supply of these machines during the period of the first five year plan. On the whole, imports of capital goods from abroad amounted to almost 15 percent of gross investment in the Soviet Union during this period. Furthermore, imports of certain basic industrial materials--lead, tin, nickel, zinc, aluminum, rubber--accounted for perhaps 90 to 100 percent of these materials consumed in the Soviet industrialization program.

After the completion of the first five year plan, Soviet foreign trade diminished. The decrease can be attributed to several factors. Among the direct economic factors were, first, trade was aimed at building import substitution capacity and was severely reduced after the delivery of necessary machinery. Second, in the recession of the thirties, terms of trade worsened for the Soviet Union, i.e., the prices of raw materials dropped significantly relative to machinery prices. Third, after the granting of the USSR Most Favored Nation (MFN) status, the attitude in the United States toward trade with the USSR shifted away from the granting of credit on favorable terms and toward conditioning trade terms on political concessions.

---

[1] See Anthony C. Sutton, Western Technology and Soviet Economic Development, 1917 to 1930, Vol. 1 (Stanford, California: Hoover Institution Press, 1968).

[2] See Franklyn Holzman, "Foreign Trade," in A. Bergson and S. Kuznets, eds., Economic Trends in the Soviet Union, pp. 287-320 (Cambridge, Mass: Harvard University Press, 1963).

In the Second Five Year Plan period, 1933-37, imports of foreign capital goods fell to about 2 percent of gross investment. Dependence upon the West for major products decreased dramatically. Sometimes, imports of equipment fell rather suddenly. For example, imports of tractors in 1931 accounted for about 60 percent of the growth of the tractor stock in that year, and in the next year no foreign tractors were imported.

What has been described portrays a traditional Russian pattern of periodic forays into the international economy, a pattern linked to the overall fitful pattern of economic development. Intense periods of rapid economic growth, during which Russia attempts to catch up with the advanced nations of the West, are followed by periods of withdrawal from the international economy.[1] Historically, when the military needs of the State were pressing, the economy was pressured by the State into rapid growth; when a degree of power parity was reached with the West, the need for rapid growth subsided and the State removed its pressure for growth; as a consequence, a period of rapid growth was followed by a period of little or no growth.

This pattern is seen in the period of Peter the Great at the beginning of the 1700s, in the period of rapid growth of the 1890s, and in the period of massive industrialization launched by Soviet leaders in the 1930s. In these past periods of importation of advanced technology, the Russians were able, within a compressed period of time, to approach contemporary economic development levels in the West and, to some extent, even the levels of contemporary technology in the West. Yet in the longer run, as the advanced nations of the West continued to develop new technology, the Russians were not able to maintain their relative position, and they fell back.

---

[1] A. Gerschenkron, Economic Backwardness in Historical Perspective, pp. 17-18 (Cambridge, 1973).

Certain aspects of why the Russians had trouble in fully assimilating advanced technology and why they have been particularly weak in maintaining technology at world levels have been amply discussed in the literature on the Soviet economy. These will be mentioned briefly and some additional observations will be added which will help explain Russian difficulties in evidence also before the Revolution.

Among the Soviet economic institutions which affect the ability of the economy to absorb, master, and create new technology, the one which has received primary emphasis in both the Western and Russian literature on the Soviet economy is the managerial incentive mechanism which has existed since the 1930s. The Soviet economy, in the past decade, has been undergoing certain administrative changes, and, while the current picture is not totally clear, the incentive mechanism is still basically related to the fulfillment of performance targets. In any such situation there are two ways of assuring success or at least increasing the prospects for success: (1) performance, and (2) keeping the target low. The second aspect of target-type rewarding is detrimental to the innovation process. Innovation always involves risk. The compensation for risk, contained in the reward for possible overplan fulfillment, is reduced by the fact that success today will mean a higher target tomorrow, and success in the system requires the regular meeting of targets. Thus, managers resist innovation and try to keep targets low. There is much discussion in the Soviet Union on how to get around this problem, but none of the reforms or reorganizations have accomplished this. Professor David Granick, in a recent SRI study,[1] maintains that attempts to improve Soviet technology assimilation through the modification of specific forms of success indicators, cost sharing and pricing devices, and the length of the plan time period against which enterprise results are evaluated will at best have limited results. These reforms appear to be primarily cosmetic. What is necessary, he states, is

---

[1] D. Granick, Soviet Introduction of New Technology: A Depiction of the Process, SSC-TN-2625-7 (SRI/Strategic Studies Center, 1975).

to change the basic managerial philosophy, to move from making managerial income and promotion rewards direct and immediate functions of measurable objective performance indicators,[1] to a system where these rewards are decided upon by superiors, using subjective evaluation criteria. The latter is the system used in East Germany and in many capitalist economies including the United States. Soviet leaders, Granick argues, could adopt this approach without doing violence to their sociopolitical beliefs and without running the major economic and political risks of radical economic reform. However, there is nothing in the Soviet literature to indicate that such a change in managerial philosophy is in the offing.

A second factor inhibiting the absorption and diffusion of advanced technology in the Soviet Union involves the organization of research and development (R&D). Considerable expenditure is devoted to R&D in the Soviet Union, but generally it is separated from the production process, and less attention is paid to development than research. As a result, while new technology is generated (and foreign technology monitored), the implementation and diffusion of such technologies are limited. For the reasons just discussed, the managers of industrial enterprises try to avoid incorporating new technology because it will cause problems and will not lead to sustained rewards. Thus, simply giving the control of R&D to the production managers is not a likely solution, since the expectation is that they will not encourage the development of new products and processes. One of the reforms currently underway, the creation of large "scientific production associations," offers the promise of bringing the Soviet organizational relationship between research, development, and production more into line with the pattern dominant in the West. In this regard, the practice appears to be to have a scientific institute as the managerial unit in the association, so as to give primacy to technical change as an objective. Though this is considered a rather promising reform, whether

---

[1] This is essentially Taylorism, which was originally designed to increase the direct productivity of semiskilled workers, not the administrative and innovational activity of managers.

it will have significant results is difficult to say, particularly within the present incentive, planning, and control environment.

A third factor contributing to Soviet difficulties is that the technology transfer process is primarily a people-process. Technology is best transferred from firm to firm and from country to country by people (managers, engineers, sales engineers, etc.) rather than by publications (including blueprints) or products themselves. In the postwar period, the Soviets have concentrated on the latter approaches while making minimal use of the former. Currently, however, they appear to be paying more attention to the people part of the process.

Related to this, but also directed toward increasing Western interest and participation in effective technology transfer to the Soviet Union, has been the current Soviet discussion of new forms of industrial cooperation with Western businesses. As Kosygin recently stated, "We are convinced that for the realization of such cooperation there can be found various organizational forms which would be to the interest of all participants."[1]

The elements discussed so far have related to Soviet institutions and practices. However, the Russians under both the Tsars and the Soviet government have had trouble mastering modern technology and maintaining its dynamic change. There are elements common to the pre- and post-revolutionary Russian scene which help explain these difficulties.

One such feature concerns the creative destruction aspect of technical change--that is, when something new is done and it is successful, the old is destroyed.[2] In the Soviet Union, and in Tsarist Russia, creative

---

[1] Kosygin at the 24th Party Congress (1971) is Gosplan SSSR, Gosudarstvennyy Pyatiletniy plan Razitiya Narodnogo Khozyaystva SSSR na 1971-1975 Gody (Moscow, 1972)

[2] In this respect, one of the advantages of a private enterprise system is that it does not internalize within the state decision sector the destruction of the old. The price paid for new technology is absorbed by individual elements in the society rather than the society as a whole.

destruction has been limited by the bureaucracy; this has been an important and difficult aspect of the whole process of technical change in the Russian economy. In general, bureaucracies tend to possess a high degree of risk aversion and the ability to protect themselves against disruption. Established bureaucratic rules and lines of authority hamper change and experimentation with new ways of doing things. Bureaucracies tend to penalize failure more than they reward innovational success. Bureaucracies tend to favor large-scale output--this has always been true in Russia--and large-scale output itself increases the cost of change. Finally, bureaucracies establish firm lines of administration preventing "invasions" of a stagnant branch by groups from a more dynamic branch. Such "innovation by invasion" has been a significant source of technology diffusion in the West.

Furthermore, the absence of a threat of bankruptcy in the non-competitive Soviet economy has an impact. In competitive economies, the innovational process responds in a positive way to high rewards for successful innovation; it also responds to the fear of being driven out of business by dynamic competitors. Indeed, the spur to innovation from the latter is probably stronger than the former. The absence of defensive innovation from the Soviet economy thus removes an important contribution to technical change.

Frequently, dynamic men do appear in leadership positions in the Soviet bureaucracy who press for change. While they may enjoy some success through the exercise of their power, they are not at the production level, and thus their influence over day-to-day operations is limited.

A final factor which should be noted is that the Soviets have primarily imported foreign technology for domestic purposes rather than for exports which would have to be internationally competitive. Thus, once the new technology was in place, there was no pressure on those using it to keep it up to changing foreign levels, and the technology languished. This was also important in the Tsarist period. The success experienced by the Japanese in developing a self-sustaining technological advancement through

the import of technology for international competitive purposes highlights the influence of the purpose of imported technology, i.e., whether it is to be used just internally or whether it is also used for international competitive purposes. Moreover, this argument contributes to an explanation of why the Soviet have done much better in military technology than in civilian technology. Military equipment is in its nature competitive; its performance and its utility can be judged only relative to the equipment possessed by the (potential) enemy; this is not generally true of nonmilitary equipment.

II AN ECONOMETRIC ANALYSIS OF THE ROLE OF TECHNOLOGY TRANSFER IN SOVIET INDUSTRIAL GROWTH, 1968-80

A. Counterfactual Use of an Econometric Model

As was stated above, while both Western observers and current Soviet policymakers appear convinced of the contribution of foreign technology to Soviet industrial growth, the quantitative significance of the technology transfer remains a major unanswered question. Much of the evidence which bears upon the static gain from technology transfer and Soviet ability to absorb and diffuse borrowed technology is anecdotal in character. Data on anticipated unit cost savings or actual productivity gains in model enterprises unfortunately do not answer the crucial issues of aggregate costs and benefits.

During the consttruction of the SRI-WEFA Econometric Model of the Soviet Union, a new methodology was developed for evaluating the quantitative impact of imported machinery on Soviet industrial production which to a certain extent provides a measure of the gains from technology transfer. The incorporation of this feature within the complete macroeconometric model provides a framework for evaluating the direct and indirect benefits of Soviet machinery imports through counterfactual scenarios in the past and conditional projections into the future.

The analysis reported here uses SOVMOD II, the second-generation version of the SRI-WEFA Soviet Econometric Model.[1] The major features of this model are described elsewhere and only the components of the model

---

[1] SOVMOD II is documented in Donald W. Green, Lawrence R. Klein and Herbert S. Levine, The SRI-WEFA Soviet Econometric Model: Phase Two Documentation, Stanford Research Institute, Technical Note SSC-TN-2970-3 and SSC-TN-2970-4, October 1975.

which bear on the issue of technology transfer will be discussed here. In Figure 1 below, the major components of the model are charted. Investment is determined by financing categories in the State budget, nonpersonnel defense expenditure and gross profits in the national economy. Capital formation depends upon current and past investment expenditures and the stage of the five-year-plan. Industrial output is a function of employment, capital, and a stock measure of foreign capital where the specification is a Cobb-Douglas production function. Imports of Soviet machinery are dependent upon domestic investment expenditures, Soviet hard currency reserves, and certain aspects of Soviet policy such as détente. Soviet hard currency exports also respond to the liquidity position, i.e., an expansion of Soviet imports will induce an expansion of Soviet exports with a lag.

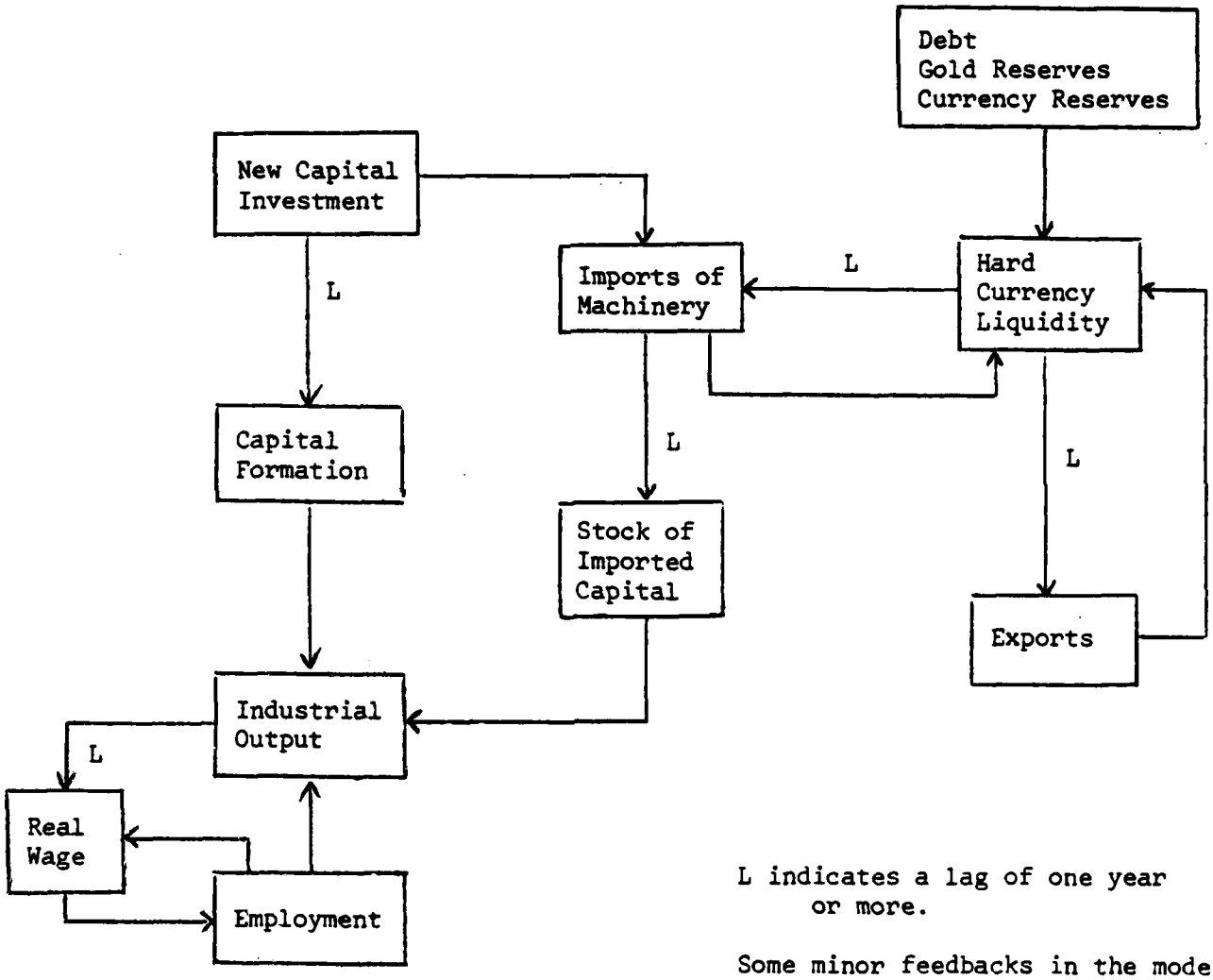
The next two sections describe (1) the specification of production when capital is disaggregated into foreign and domestic categories, and (2) the specification of Soviet demand functions for foreign machinery. Then a control solution or base-line simulation of Soviet economic growth for the period 1968-80 is described. Using this control solution as a reference, the economic losses to the Soviet Union had East-West trade not expanded rapidly in the post-1968 period can be estimated. In addition, dynamic multipliers can be estimated for Soviet machinery imports by shifting those demand functions upwards and downwards. Finally, the paper discusses the reasonableness of these efforts at quantification and emphasizes the assumptions upon which the estimates depend.

B. Imported Machinery and Technology Transfer

The gains from technology transfer internationally will depend upon the technical gap between nations and the absorptive efficiency of the receiving nation (its capacity for learning and absorption). In an attempt to quantify the gains from technology transfer, there are clear advantages to focusing on imported machinery and equipment. Machines imported from

FIGURE 1

Technology Transfer Component of SOVMOD II



L indicates a lag of one year or more.

Some minor feedbacks in the model have not been included in this diagram.

nations more technologically advanced can shift a domestic production function upward in three different ways:

- directly through higher productivity in domestic production
- indirectly through use in the production of more efficient domestic machinery
- even more indirectly through the transmission of information which results in a higher domestic level of technology.

The value of information embodied in foreign machines will rarely be fully captured by the transaction price, for the usual gains-from-exchange arguments.

In the case of the Soviet Union, there are two additional reasons for using observed imports of machinery and equipment to increase our understanding of the determinants of production and technical change. First, as was argued, technology transfer through machinery imports has played a prominent role in past Soviet economic development. Indeed it is somewhat surprising that few Western economists have considered the transfer issue in their analysis of Soviet factor productivity.[1] A second reason is that

---

[1] One notable exception has been Stanislaw Gomulka's innovative work on intercountry embodied technological diffusion. In Golmulka and Sylwestrowicz ("Intercountry Embodied Diffusion and the Time Changes in the Factor Productivity Residual," in F. L. Altman, O. Kyn, and H. J. Wagener, eds., On the Measurement of Factor Productivities: Theoretical Problems and Practical Results, Papers and Proceedings of the 1974 Reisenburg Symposium, Gottingen, Vandenhoek and Ruprecht, forthcoming) a method is introduced for calculating the effect of imported investment goods upon the growth rate of labor productivity where there exists a technological gap. This diffusion effect is strictly determined by intercountry differences in labor productivity and the structure of domestic capital stock. In his later Banff paper, Gomulka ("Soviet Post-War Industrial Growth, Capital-Labor Substitution and Technical Change: A Re-Examination," Proceedings of the Banff '74 International Conference, forthcoming) rejects this diffusional effect as a major cause of the retardation of Soviet industrial growth although this effect was not incorporated in the specification.

imports of machinery and equipment are reported in Soviet statistics and thus are available to us. However, these data must be treated very carefully because of certain features of Soviet accounting practice. Not only is the domestic value of an imported machine not accurately reflected in the world market price, it is also rarely reflected in the internal price paid by the Soviet enterprice or in the price assigned for inclusion of the machine in capital stock statistics.

The incremental output derived from new capital will be dependent on the foreign/domestic composition of that capital. In order to estimate the contribution of imported machinery to Soviet industrial production, a measure of foreign capital from Soviet import data is constructed and then used to disaggregate the capital stock into foreign and domestic categories.

The construction of a measure of foreign capital in constant domestic rubles requires appropriate deflation of observed machinery imports and assumptions about conversion coefficients, installation lags, and a retirement rate. The appropriate dating for the import flow and price deflator are difficult to set a priori since machinery gestation lags may vary and import transactions registered in a current year may reflect contract prices of previous years. It is assumed that all machinery imports become operable in the year following their importation into the Soviet Union. Our measure of foreign capital stock on January 1 is calculated as follows:

$$(1) \qquad K^F_t \equiv (1 - d^F)\, K^F_{t-1} + P^K_{t-1} \cdot M\&_{t-1}/P^M_{t-1}$$

where d^F Retirement rate for imported machinery

K^F Capital Stock, Foreign Machinery

M& Machinery Imports, Current Rubles

P^K Price Conversion, 1969 Machinery Prices into 1955 Capital Prices

P^M Price Deflator, Imported Machinery.

Capital stock of domestic origin (K^D) is then derived as the difference between reported capital stock (K) for the sector and the foreign component:

$$(2) \qquad K_t^D \equiv K_t - K_t^F .$$

Over the period 1960-73, there are some important patterns in the growth of foreign capital in Soviet industry. From the capital measures just described, annual growth rates are computed and presented in Table 1. A striking feature for aggregate industry, chemicals and machine-building is the decline in the growth rate of foreign capital in 1965-67. This is a period of reduced industrial investment, low growth in Soviet industry, and export surpluses to the Developed West. The early 1960s were a period of substantial imports of machinery for the chemicals and petroleum branches, while for aggregate industry the most rapid growth in machinery occurs after 1968.

Table 1

RATES OF GROWTH OF FOREIGN CAPITAL, 1961-73

Year	Aggregate Industry	Chemicals and Petrochemicals	Machine-Building and Metalworking	Petroleum Products
1961	5.2	19.8	9.6	16.9
1962	6.7	15.4	9.8	27.0
1963	7.9	7.3	11.2	31.4
1964	6.2	11.1	10.3	27.4
1965	4.1	8.3	10.7	25.9
1966	2.5	6.9	7.3	21.5
1967	3.4	9.7	5.3	10.9
1968	6.7	10.8	6.2	11.8
1969	10.0	10.9	8.8	13.6
1970	11.6	5.5	7.8	10.2
1971	8.0	0.4	21.6	7.5
1972	7.1	3.4	6.8	8.4
1973		10.0	10.8	5.1
Mean Growth Rate 1961-72	6.6	9.1	9.6	17.7

Using the disaggregated series of foreign and domestic capital stock, a production function was estimated with three factors of production: labor, foreign capital and domestic capital.[1] It is assumed each imported machine carries potential information which may raise the level of Soviet technology. Given a constant expenditure of internalization effort (analysis and diffusion) per unit of imported machinery, the level of domestic technique will depend upon current and past levels of machinery imports. When one estimates the "contribution" to output of the marginal foreign machine, there are two components to the marginal productivity: (1) a direct measure of productivity, and (2), its contribution to the productivity of domestically produced machinery. If this "learning" component is significant then the marginal productivity of foreign capital estimated in a production function ought to be higher than what one might judge reasonable for direct productivity relative to domestic capital. And that is exactly what the econometric results suggest.

Using the disaggregation of capital, described above, and data on employment and output, a Cobb-Douglas production function in log linear form was estimated:

$$(3) \qquad \ln X_t = \beta + \alpha^L \ln L_t + \alpha^F \ln K_t^F + \alpha^D \ln K_t^D .$$

In the estimations no trend term is included, which assumes no Hicks-neutral technical progress--technical progress occurs only through the addition of more factor inputs. From the estimates of α^F and α^D, and the sample period means for K_t^F and K_t^D, a ratio of marginal products for foreign and domestic capital can be computed as follows:

---

[1] Those interested in the theoretical basis for this procedure, its econometric characteristics, and the data used should refer to the earlier paper by Green and Jarsulic ("Imported Machinery and Soviet Industrial Production, 1960-1973: An Econometric Analysis," Soviet Econometric Model Working Paper #39, September 1975).

$$(4) \qquad RK \equiv \frac{\hat{\alpha}^F}{\bar{K}^F} \Big/ \frac{\hat{\alpha}^D}{\bar{K}^D} \qquad \text{where}$$

RK ratio of marginal products

$\hat{\alpha}^F$ estimate of the output elasticity of foreign capital from (3) above;

$\hat{\alpha}^D$ estimated output elasticity for domestic capital

$\bar{K}^F$ sample mean of K_t^F, and

$\bar{K}^D$ sample mean of K_t^D .

Table 2 presents the derived measures of RK for aggregate Soviet industry and three industrial branches: chemicals, machine-building and petroleum products.

Table 2

ESTIMATION RESULTS: RATIO OF MARGINAL PRODUCTS*

Category	Western or Total Imports	α^F	α^D	$\bar{K}^F/K^{-D}$	RK
Aggregate industry	Western	0.228 (7.04)	0.374 (17.25)	0.040	15.2
Chemicals and petrochemicals	Western	0.488 (2.08)	0.227 (1.78)	0.120	17.9
Machine-building and Metalworking	Total	0.162 (0.83)	0.506 (1.93)	0.043	7.4
Petroleum products	Total	0.235 (8.65)	0.433 (9.25)	0.096	5.7

* t-statistics for estimated parameters are in parentheses. Sample-period means for capital measures are computed over the period 1960-72.

C. Soviet Demand for Foreign Machinery

Demand functions for imported machinery in open capitalist economies usually include a more aggregate category of demand (e.g., total demand

for machinery and equipment) and a relative price term indicating the competitiveness of domestic machinery in the world market. Decision agents are, by hypothesis, profit-maximizing enterprises and not national governments. The specification of Soviet demand functions for foreign machinery, however, must take into account the existence of the foreign trade monopoly and the disequilibrium price set for foreign exchange. Foreign exchange, particularly hard currencies, is a scarce resource rationed by the Ministry of Foreign Trade under the direction of the Council of Ministers and Gosplan. Ministries and enterprises compete, through both political and economic channels, for imported machinery as for other scarce economic resources.

In the Soviet macromodel, the pattern of bureaucratic behavior regularity (rules of thumb), is specified, the contingencies to which such bureaucratic rules must respond are identified, and, where possible the role of administrative intervention in shifting the rule from epoch to epoch are clarified. The general specification used for these demand functions is as follows:

$$(5) \quad \frac{M\$/PM}{INV} = \alpha_0 + \alpha_1 FLIQ_{-1} + \alpha_2 QDET$$

where M$ is Machinery imports in Current $

PM is Machinery price deflator

INV is Domestic Investment in Constant Rubles

$FLIQ_{-1}$ is Liquidity Position at the End of the Previous Year (value of gold reserves in current $, less debt in current $, all of this divided by total imports from Developed West in current $)

QDET is Dummy Variable for Détente (post 1968).

The "rule of thumb" in this hypothesis is that real foreign machinery is allocated proportionately to the allocation of domestic investment over time within any given category of investment. If the two right-hand variables are normalized to a mean of zero, α_0 represents an equilibrium ratio for this particular category. FLIQ is a dimensionless measure of Soviet liquidity in foreign exchange so α_1 is a response coefficient which shifts the import ratio according to variations in liquidity. The parameter α_2

measures the impact of détente on foreign machinery demand where QDET usually combines a shift after 1968 and an upward trend thereafter. In scenario and projective analysis these parameters and varies, and the consequences for Soviet trade and for domestic production where the M$ variable is linked to a measure of imported capital included in production functions are observed.

There are two additional implications of the specification given in Equation (5). First, a given percentage increase in domestic investment will raise imports by the same percentage, all other things remaining constant. This assumes that hard currency will be allocated proportionately to those sectors or branches which attract investment funds. Second, an increase in world machinery prices will raise imports proportionately in the current year but depress the import ratio in subsequent years because of the impact on liquidity in foreign exchange.

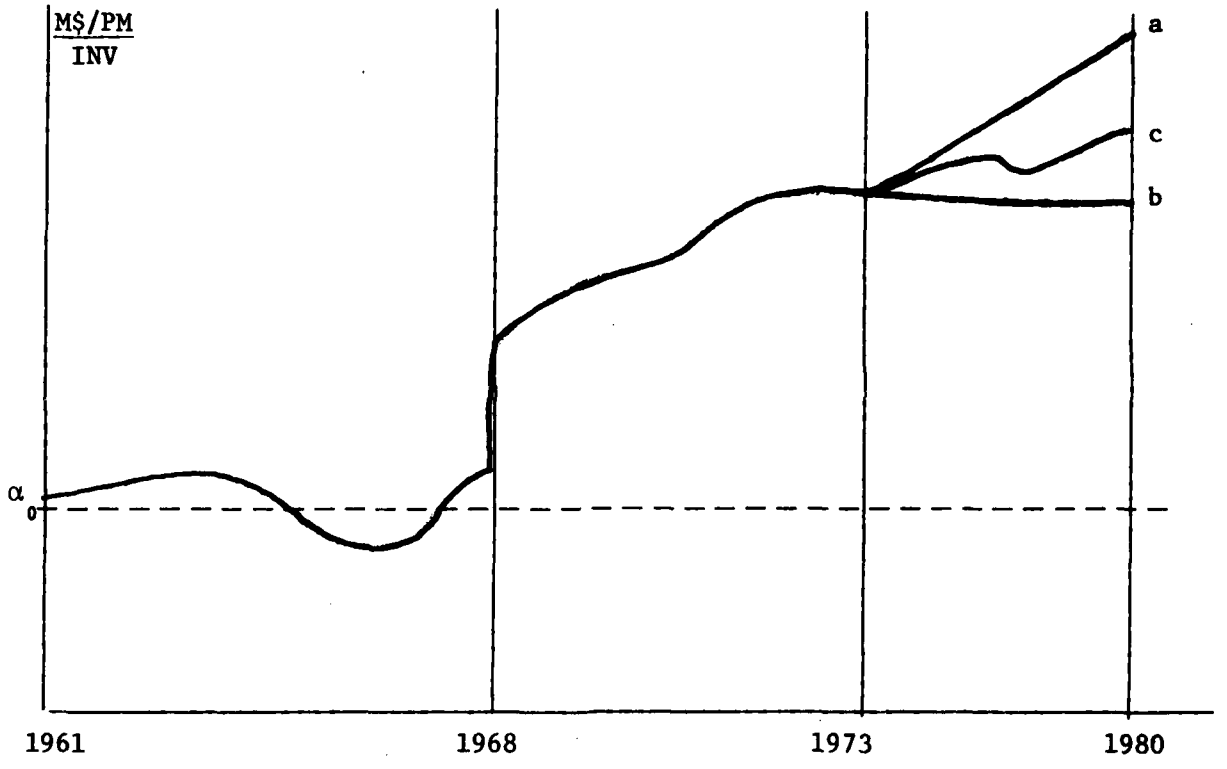
In Figure 2 below, the general historical pattern in the observed import/investment ratios is indicated. Over the sample period 1961-73, the equilibrium ratio is shifted upward with détente with shortrun variation "explained" in part by the liquidity measure. The retardation in real machinery imports in the mid-1960s is due first to the restriction in industrial investment and second to the decline in Soviet hard currency liquidity after the 1963 harvest failure. Several different projection patterns are indicated for the period 1974-80: projection (a) continues the upward trend observed in the period of détente; projection (b) continues the détente shift but abandons the upward trend; and projection (c) represents a combination of projection (a) with declining Soviet liquidity because of grain purchases in 1975-76.

D. Scenario I: A Retrospective Repeal of "Détente," 1968-73

In the estimation of Soviet demand functions for foreign machinery, the upward shift in these functions after 1968 is attributed to a policy decision to close the technology gap with the West through increased

Figure 2

HISTORICAL PATTERN OF THE IMPORT/INVESTMENT RATIO



trade. These considerations were an important element in the Soviet strategy of détente, along with the reduction of European tensions and prospects of arms limitation agreements. Using the SRI-WEFA Model the following counterfactual question is asked: How might Soviet development been different had those shifts in Soviet machinery demand not taken place? By retrospectively repealing "détente" consequences for East-West trade, a measurement of Soviet gains from machinery imports is obtained by holding constant the historical environment, i.e., financing of investment, defense expenditure, weather, the world economy, etc.

In the scenario analysis, first, a control solution as a standard of reference for counterfactual experiments is constructed. For the control solution, the model is solved dynamically from 1968 to 1973 using actual historical values for all variables in the period of solution. The version of SOVMOD II utilized has consumption determined as the residual category of end-use, and Soviet gold sales and imports of grain from the Developed West are exogenous rather than determined by the model solution. Some minor adjustments were made to this control solution to reduce prediction errors in Soviet foreign trade with the CMEA and the Developed West. The adjustments are applied to the scenario solution as well as the control. The main features of this control solution are indicated in Appendix A to this paper.

Once the control solution is determined, a No-Détente scenario is computed by setting the détente coefficients of the machinery import equations to zero (coefficient α_2 in Equation (5)). Referring back to Figure 1, only the machinery import component of the model is adjusted. Industrial investment and capital formation are unchanged; only the foreign/domestic composition of industrial capital stock is different with consequences for industrial production. The decline in Soviet imports results in an increase in Soviet hard currency liquidity which acts to boost machinery imports in the following year. The hard currency liquidity gain also lessens next year's exports to the Developed West which in turn lowers the liquidity position in the year after that. The shift in capital composition also generates another

systemic process through the employment loop. A reduction in the growth of average labor productivity in industry lowers the growth of the real industrial wage. This reduces subsequent growth in industrial employment through participation effects and, with a longer lag, through a rural/urban migration effect.

In comparing the Scenario with Control, the full system impacts of the détente effect on Soviet machinery imports is observed. Table 3 presents several measures which indicate the magnitude of this détente effect. The model suggests that the growth of industrial production from 1968 to 1973 would have been only 28.4 percent without those additional imports of Western machinery, i.e., approximately 15 percent of the growth rate in the control solution (33.7 percent) would have been foregone. In this version of the model with no compensatory policy shifts, nearly the full impact of this loss in GNP falls upon consumers. At the end of the period, the USSR has a stronger hard currency position with $1.2 billion additional reserves in the No-Détente Scenario with a slower expansion in foreign trade turnover.

Beyond the indicators presented in Table 3, a dynamic multiplier in 1970 prices relating incremental industrial production to incremental machinery imports was constructed. The data and computational procedure used are presented in Table 4. The implied multiplier of approximately 15 is quite large and several comments are in order. First, the disturbance in machinery imports is rather substantial relative to control values so the marginal products derived in the production function estimation may be inappropriate. Second, this magnitude reflects in part the overvaluation of the ruble by the official exchange rate; for example, if the ruble were overvalued by a factor of two, the multiplier would be reduced to 7½. Third, this measurement is in some respects underestimated since even with a return to the control path in 1973, industrial production would remain below control thereafter because of the no-détente deficiency in the stock of Western machinery (nearly 2 billion rubles in 1973).

Table 3

THE IMPACT OF DÉTENTE: MAIN INDICATORS

Indicator	Détente Control	No Détente Scenario
	Percentage Growth, 1968-73	
Gross national product	30.3	27.7
Industrial production	33.7	28.4
Chemicals and petrochemicals	33.9	26.6
Machine-building	42.6	40.8
Foreign trade turnover	57.9	52.9
Aggregate consumption	26.0	21.9
	Value in 1973	
Imported Western machinery (Billion 1955 rubles)	10.14	8.27
Hard currency reserves (Million current $)	-318.	878.

Table 4

DERIVATION OF THE DYNAMIC MULTIPLIER FOR
WESTERN MACHINERY, 1968-73

MIMDW$	Soviet Imports of Machinery and Equipment for Industry from the Developed West (Billion Current $)
XIT	Soviet Industrial Production (Billion 1970 Rubles)
PM	World Machinery Price (1970 ≡ 1.) (German Export Deflator for Non-Electrical Machinery)
Δ	Control Less Scenario

	ΔMIWDW$	ΔMIWDW$/PM	ΔXIT
1968	.271	.3358	0.00
1969	.271	.3125	1.00
1970	.332	.3320	2.76
1971	.374	.3319	4.38
1972	.457	.3850	6.20
1973	.603	--	8.29
		.16973	22.63

$$\text{Dynamic Multiplier} \equiv \sum_{1969}^{1973} \Delta XIT \Big/ \sum_{1968}^{1972} \frac{\Delta MIMDW\$}{PM} / 1.11 = 14.8$$

where 1.11 is the Official Exchange Rate in 1970.

E. Scenario II: The Projected Benefits of Imported Machinery for Soviet Industrial Growth, 1973-80

The situation of the Soviet economy in the mid-1970s is somewhat different from that of the mid-1960s, in part because of the substantial imports of Western machinery during the period 1968-74. To increase our understanding of the quantitative contribution of technology transfer, projective scenarios with 10 percent upward and downward shifts in Soviet demand for foreign machinery were constructed. For projective analysis, the derivation of a control solution is considerably more difficult than for retrospective analysis because of uncertainty concerning the paths of exogenous variables. For these scenario exercises, a control solution was prepared for an extended analysis of the Tenth Five Year Plan.[1] The version of SOVMOD II used is the same as that for Scenario I (with the "détente" effects restored).

The major assumptions used in the determination of a control solution for 1973-80 are presented in Appendix B. A moderate growth rate of 5 percent (slightly higher for agriculture), somewhat less than the observed growth rate for 1966-75, was projected for the important financing variables. The projection assumes "normal" weather for the period 1976-80. For the world economy, a real growth at 7 percent and world trade inflation at 7 percent (1976-80) was projected. Raw material prices are expected to grow at a lower rate, as are CMEA foreign trade prices. A stable exchange rate for the ruble and stable gold prices (at $120 per ounce) were projected.

In establishing a control solution for 1973-80, there have been several types of adjustments introduced:

- additional information for the period 1973-75 was imposed on the model's solution path for those years

---

[1] This analysis will appear in a paper on the Tenth Five Year Plan to be published in a volume by the Joint Economic Committee, U.S. Congress, 1976.

- certain trends embedded in estimated equations of the model were modified or suppressed given additional information from the Tenth Five Year Plan and elsewhere

- adjustments were made to other variables taking into account probable Soviet responses to trends observed in the State budget, household accounts, and foreign trade.

Since 1973 data for some variables in the model were not available, the model projection must begin in that year. Solution values for that year, however, may be adjusted to conform to the actual data in hand. Similar adjustments were made to solution values in 1974 with data from the official Soviet Statistical Handbook recently published. For 1975, the most important adjustments involve the 140 million metric ton grain harvest and its impact upon total agricultural output and light industry.[1]

Several trend coefficients estimated in the model over a sample period 1958-72 were modified for use in long-term projections. The major modifications in this regard involved the equations determining the urban share of total population and the participation rate for the urban population. Our adjustments downward for these variables result, for example, in a 7 percent growth rate in industrial employment over the period 1976-80 rather than the 12-14 percent for an initial projection. Similar trends were modified or suppressed for the negotiated agricultural price, the wholesale industrial price, and investment in transport/communications, housing and services.

The final category of user intervention in the derivation of a control solution involves the recognition of inconsistency, and the imposition of plausible adjustments to lessen inconsistency in the projection. For example, the initial projections with SOVMOD II resulted in very large Soviet trade deficits with the CMEA in the late 1970s (nearly $4 billion

---

[1] These adjustments have been described in an earlier informal note: Donald W. Green, "The 1975 Soviet Grain Harvest, The Tenty Five Year Plan and the U.S./USSR Grain Agreement," unpublished manuscript, December 1975.

annually). Such deficits arose from rapid growth (15-18 percent per year) in Soviet imports of machinery and raw materials from the CMEA. These deficits and import growth rates were infeasible, for both economic and political reasons, and the growth rates for imports from CMEA were adjusted downward to a 12-13 percent level. A similar problem arose for Soviet hard currency trade, and credit drawings and gold sales were increased to reduce the deficit in hard currency to "manageable" levels. Certain categories of revenue in the State budget were adjusted to new tax rates implied by the 1973-74 data in order to close the projected deficit in the State budget.

The control solution for 1973-80 is presented in Appendix C and the main indicators of that solution are compared with the Tenth Five Year Plan in Table 5 below. In general, the aggregate output targets of the Plan appear to be feasible by the standards of SOVMOD II. However, our projection anticipates more growth in employment and capital investment and fewer gains from technical progress than called for in the Plan.

Around this control path two scenarios were constructed by shifting Soviet demand functions for foreign machinery. In Scenario II-A all features of the control solution are maintained except that the parameter α_1 in each machinery demand function is increased by 10 percent. In Scenario II-B, those parameters are reduced by 10 percent. Consequently, multipliers in both directions for imported machinery can be calculated. The broad features of these scenarios are presented in Table 6 and the computation of impact multipliers is outlined in Table 7. Two important observations derive from these experiments. First, the multipliers for Western machinery are lower for the USSR in the 1970s than they were at the end of the 1960s, though they are still large. With the more rapid accumulation of Western machinery relative to domestic capital in the period of détente, the ratio of marginal products given in Equation (4) has declined from the sample-period level. Second, the multiplier downwards is greater than the multiplier upwards for the same reason. These characteristics would appear as long as the elasticity of factor substitution in the production function is unitary or less.

Table 5

MAIN INDICATORS OF THE NINTH AND TENTH FIVE-YEAR PLANS

Ninth Five-Year Plan Period, 1971-75

Indicator: Rates of Growth	(1) Official Plan Target	(2) Official Claim	(3) SOVMOD II Control
GNP	-	-	26.0%*
National income	38.6%	28.0%	-
Industrial output	47.0%	43.0%	43.0% (34.)†
Industrial labor productivity	39.0%	34.0%	32.4% (24.1)†
Industrial employment	5.9%	6.7%	8.0%
Agricultural output (5-year average)	21.7%	13.0%	12.0% (10.)†
Real income per capita	31.0%	24.0%	21.8%
New capital investment	41.6%	-	40.8%
Total consumption	-	-	24.0%
Foreign trade turnover	33.-35.%	-	54.0%

Tenth Five-Year Plan Period, 1976-80

Indicator: Rates of Growth	(2) Preliminary Plan Target	(3) SOVMOD II Control
GNP	-	23.8%*
National income	24.-28.%	-
Industrial output	35.-39.%	40.6% (31.8)†
Industrial labor productivity	30.-34.%	32.4% (24.1)†
Industrial employment	4.2%	6.2%
Agricultural output (5-year average)	14.-17.%	11.2% (9.2)†
Real income per capita	20.-22.%	16.6%
New capital investment (5-year total)	24.-26.%	30.0%
Total consumption	-	23.6%
Foreign trade turnover	30.-35.%	25.0%

* Since 1975 GNP is depressed because of the poor harvest, a Five-Year Moving Average (1973-77) of the Control Solution was used in comparisons with 1970 and 1980.

† Model projections on Western data basis (in parentheses) converted to Soviet data basis using simple adjustment factors observed 1966-70.

Sources: (1) N. K. Baybakov (General Ed.), Gosudarstvennyy pyatilentniy plan razvitiya narodnogo khozyaystva SSSR na 1971-1975 gody, Moscow, 1972.
(2) Pravda, 15 December 1975.
(3) SOVMOD II Control: 9 March 1976.

Table 6

CONTROL SOLUTION AND DEMAND-SHIFT SCENARIOS, 1973-80

Indicator	Scenario II-B 10% Decrease	Control Solution	Scenario II-A 10% Increase
		1975-80 Growth	
Gross national product*	23.5%	24.0%	24.6%
Industrial production†	39.5 (30.8)%	40.6 (31.8)%	41.7 (32.8)%
Petroleum products	42.5 (36.6)%	43.4 (37.5)%	44.4 (38.5)%
Chemicals & petrochemicals	52.5 (31.3)%	55.0 (33.5)%	57.4 (35.5)%
Machine building	53.6 (32.7)%	54.5 (33.5)%	55.0 (33.9)%
		1980 Value	
		(Billion 1955 Rubles)	
Stock of imported machinery			
Aggregate industry	18.41	19.57	20.72
Petroleum products	3.18	3.37	3.57
Chemicals & petrochemicals	3.45	3.67	3.88
Machine building	3.46	3.66	3.85

---

* Five-Year Moving Average for 1975.

† Western sample indexes for Soviet industrial output are in parentheses. These growth projections are converted to Official Soviet statistics using adjustment factors determined for 1966-70.

Table 7

SCENARIO II: DYNAMIC MULTIPLIERS

Symbols as in Table 4 above.

Scenario II-A: 10% Increase

Scenario II-B: 10% Decrease

Year	Both Scenarios (±) ΔMIMDW$/PM	Scenario II-A ΔXIT	Scenario II-B ΔXIT
1973	.105	0.00	0.00
1974	.132	0.35	-0.36
1975	.153	1.00	-1.02
1976	.148	1.58	-1.62
1977	.163	2.08	-2.15
1978	.178	2.60	-2.70
1979	.196	3.15	-3.29
1980	.214	3.71	-3.89

Upward Multiplier = 12.1
(1973-78)

Downward Multiplier = 12.4
(1973-78)

Multipliers calculated for the full 8-year period are over 15. We have presented six-year multipliers to facilitate comparison with Scenario I.

III CONCLUSIONS

There appears to be an apparent contradiction between the qualitative impression of Soviet difficulties with the absorption of advanced technology at the microeconomic level and the quantitative estimates of the impact of imported Western machinery at the macroeconomic level, derived from the SRI-WEFA Soviet econometric model. The results appear to show a greater payoff to the importation of foreign technology than might have been assumed from the qualitative-analytical and anecdotal literature (both Western and Soviet) on the Soviet economy.

A number of methodological problems in calculating Soviet gains from technology transfers come into focus when the process of technology transfer is considered more carefully. Two of the major ones are omitted costs and returns to scale in the technology transfer process.

In this study the reported Soviet expenditure on imports of Western machinery is related to the derived increments of industrial output. However, the process of technology transfer involves additional expenditures of domestic resources (particularly skilled manpower) as well as supplementary payments for technical assistance from abroad. Unfortunately, these expenditures at the aggregate level, at least those involving domestic resources cannot be observed.

To refine the estimates of the contribution of imported machinery, quantitative measures of the supplementary expenditures need to be derived. For example, a sample of transfer projects could be evaluated to determine a ratio of domestic resource expenditure to external expenditures on physical machinery and equipment. If one were to adopt the common "rule of thumb" of three rubles internal expenditure for each ruble of external expenditure, the impact multipliers would be reduced by a factor of four (from 12-15 to 3-4). This issue bears particularly on the "reasonableness"

of the no-détente scenario (Scenario I). One would expect that a reduction in the scale of imports would release domestic technology "transfer" resources to the factory floor, with a consequent increase in production from the Scenario I path. However, in principle at least, this potential reallocation of factors within aggregate industry should already be taken into account by the econometric estimation over the sample period.

The second problem involves the important issue of scale in technology transfer. One may think of a continuum of technology transfer projects ranked according to an effectiveness criterion (a Soviet rate-of-return). Such a continuum of potential projects will exist in each time period. If the scale of aggregate technology transfer, as measured by the level of machinery imports, is increased then one assumes that projects of lower productivity will be undertaken. Similarly, if the scale of technology transfer is reduced, the effectiveness of the marginal product should rise. Specifying the production function as unitary elastic (Cobb-Douglas) tends to move the results in that direction, but perhaps by too little. In future research, it may be appropriate to impose such a technology on the transfer process itself and reestimate production functions subject to this additional constraint.

A major task remains of reconciling the macroeconometric results in this paper with the microeconomic evidence presented in other papers on this topic. To make a tentative step in that direction consider first the issue in a framework of comparative statics and then look briefly at problems of comparative dynamics.

Consider the Soviet economy on 1 January 1973, where the ratio of imported Western industrial machinery to all other industrial capital is approximately .05. Suppose also that the hypothetical ratio of direct capital productivities is only 2 according to the judgments of knowledgeable Soviet engineers and microeconomists. How reasonable then is an estimated dynamic multiplier of 10? That means that had the economy imported 1 billion rubles more Western machinery with the same aggregate

capital accumulation before January 1, industrial production in 1973 would be 10 billion rubles more. This is expressed in total differential forms:

$$\Delta X = MPK^F \cdot \Delta KF + MPK^D \cdot \frac{\Delta K^D + \Delta MPK^D}{\Delta K^F} \cdot K^D$$

where K^F and K^D are fixed.

The last term is the impact of learning by importing. With $MPK^F = rMPK^D$, this reduces to the following expression:

$$\begin{aligned} \Delta X &= MPK^F - MPK^D + \Delta MPK^D \cdot K^D \\ &= rMPK^D - MPK^D + \Delta MPK^D \cdot K^D \\ &= (r-1)MPK^D + \Delta MPK^D \cdot K^D. \end{aligned}$$

This expression may be rearranged to relate the percentage increase in the marginal product of domestic capital to the domestic capital stock and its marginal product:

$$\frac{\Delta MPK^D}{MPK^D} = \frac{1}{K^D} \left[\frac{\Delta X}{MPK^D} - r + 1 \right].$$

With K^D = 300 billion 1972 rubles, the inverse relationship between the marginal product and its percentage increase because of incremental machinery imports may be indicated by the following table:

(r) Ratio of Direct Marginal Products	$MPK^D = 0.5$	$MPK^D = 0.25$
2	6.3%	13.0%
3	6.0%	12.7%
4	5.7%	12.3%
5	5.3%	12.0%

To account for an estimated multiplier of 10, the compositional shift in Soviet industrial capital in the hypothetical experiment of 1 billion rubles would have to raise the marginal product of non-Western capital by 6 to 13 percent.

On the basis of this simple experiment, the magnitude of the impact of Western technology is not unreasonable and could be accepted by micro-economic analysts. However, it would make a difference whether that additional billion rubles of Western machinery was imported in the preceding year or spread evenly over the previous 10 years. This brings up the issue of diffusion rates and the dynamic process of technology absorption. The econometric specification which was used implicitly assumed that the productivity impact (learning and diffusion) occurs with a lag of only one year. This is in sharp contrast to the judgments of both Soviet and Western economists. It would be useful to shift to a vintage capital market with efficiency weights related to a distributional lag over past machinery imports. The introduction of such a dynamic specification for Soviet production functions may require the imposition of further assumptions in order to identify the impact of "learning by importing." This is a promising direction for future research.

APPENDIX A

SRI-WEFA ECONOMETRIC MODEL OF THE USSR
DETENTE CONTROL SOLUTION 1960-73
DATE: FEBRUARY 20,1976

#	DESCRIPTION	MOD. VAR.	LAGGED 1967	1968	FORECAST DATA 1969	1970	1971	1972	1973
1	GNP,SECTOR-OF-ORIGIN,B.1970R	9611	301.17	317.42	336.01	357.90	374.44	387.63	413.70
2	PERCENTAGE GROWTH IN GNP		6.16	5.40	5.86	6.51	4.62	3.53	6.72
3	GNP PER CAPITA, 1970 RB/PERSON		1269.67	1325.35	1390.20	1467.39	1520.24	1559.27	1648.87
4	GROWTH IN GNP PER CAPITA		5.09	4.39	4.89	5.55	3.60	2.57	5.75
5	GNP,SECTOR-OF-ORIGIN,B.1970R								
6									
7	AGRICULTURE	9511	52.59	54.03	54.76	60.08	59.30	55.54	63.23
8	-GROWTH		-0.19	2.74	1.35	9.70	-1.30	-6.34	13.86
9									
10	INDUSTRY		146.60	155.38	166.20	176.29	186.75	196.42	207.70
11	-GROWTH,TOTAL		7.79	5.99	6.96	6.07	5.94	5.18	5.78
12	-GROWTH,BY BRANCH								
13	ELECTROENERGY		7.69	10.10	7.65	5.93	7.54	6.17	5.62
14	COAL PRODUCTS		2.32	2.60	1.21	2.69	2.07	1.96	1.34
15	PETROLEUM PRODUCTS		9.00	6.06	9.73	6.61	5.97	5.99	6.72
16	FERROUS METALLURGY		6.77	5.60	5.26	4.30	4.10	3.58	3.30
17	NON-FERROUS METALLURGY		8.64	7.79	8.20	5.00	7.01	4.39	6.24
18	CONSTRUCTION MATERIALS		7.75	3.71	7.45	5.54	6.04	7.06	7.80
19	CHEMICALS & PETROCHEMICALS		10.01	11.37	8.22	5.01	4.82	4.49	7.56
20	MACH.BLDG.& METAL-WORKING		7.23	7.50	6.87	6.83	8.91	7.29	6.86
21	FOREST PRODUCTS		5.84	5.94	3.42	2.70	1.82	2.61	2.26
22	PAPER & PULP		8.17	5.36	6.43	5.17	5.97	5.22	5.55
23	SOFT GOODS		9.30	12.67	4.75	3.80	5.02	3.08	1.84
24	PROCESSED FOODS		6.87	4.76	4.59	3.34	5.16	2.76	2.11
25									
26	CONSTRUCTION		21.46	22.75	24.39	26.43	28.27	30.36	32.12
27	-GROWTH		8.48	6.01	7.22	8.35	6.98	7.38	5.79
28									
29	TRANSPORT/COMMUNICATION		28.54	29.88	32.06	34.30	36.68	39.26	42.04
30	-GROWTH		9.04	4.69	7.31	7.00	6.94	7.03	7.06
31									
32	DOMESTIC TRADE		13.65	15.07	16.27	17.11	18.08	19.02	19.65
33	-GROWTH		9.10	10.40	7.97	5.12	5.66	5.20	3.35
34									
35	SERVICES/GOVERNMENT		38.33	40.32	42.33	43.69	45.36	47.04	48.88
36	-GROWTH		4.92	5.18	4.99	3.23	3.82	3.71	3.92
37									
38	NET MATERIAL PRODUCT,B.1970R		262.83	277.10	293.68	314.20	329.07	340.59	364.82
39	PERCENTAGE GROWTH IN NMP		6.34	5.43	5.98	6.99	4.73	3.50	7.11
40	GRAIN OUTPUT,M.TONS	3378	96.13	108.01	104.13	131.41	129.24	112.59	142.28
41	GROWTH IN GRAIN OUTPUT		-15.30	12.36	-3.59	26.20	-1.66	-12.88	26.37
42	SHARES OF SECTORS IN GNP								
43	AGRICULTURE		0.17	0.17	0.16	0.17	0.16	0.14	0.15
44	INDUSTRY		0.49	0.49	0.49	0.49	0.50	0.51	0.50
45	CONSTRUCTION		0.07	0.07	0.07	0.07	0.08	0.08	0.08
46	TRANSPORT/COMMUNICATION		0.09	0.09	0.10	0.10	0.10	0.10	0.10
47	DOMESTIC TRADE		0.05	0.05	0.05	0.05	0.05	0.05	0.05
48	SERVICES/GOVERNMENT		0.13	0.13	0.13	0.12	0.12	0.12	0.12

SRI-WEFA ECONOMETRIC MODEL OF THE USSR
DETENTE CONTROL SOLUTION 1968-73
DATE: FEBRUARY 20,1976

#	DESCRIPTION	MOD. VAR.	LAGGED 1967	FORECAST DATA 1968	1969	1970	1971	1972	1973
1	GNP,END-USE,B,1970R		301.17	317.43	336.05	357.94	374.47	387.68	413.75
2	GROWTH IN END-USE GNP		6.16	5.40	5.86	6.51	4.62	3.53	6.72
3	CONSUMPTION,TOTAL	1341	179.03	191.52	201.52	209.80	220.57	229.65	241.22
4									
5	FOOD	1350	89.81	95.04	97.93	102.57	106.89	111.21	116.18
6	SOFT GOODS	1360	39.16	42.76	45.70	47.54	50.59	53.10	56.25
7	DURABLES	1370	11.30	12.52	13.65	14.21	15.23	15.87	16.77
8	SERVICES	1380	38.74	41.20	44.24	45.48	47.87	49.47	52.02
9									
10	INVESTMENT,TOTAL NEW FIXED	191	66.03	71.33	73.79	80.84	86.11	93.58	101.25
11									
12	AGRICULTURE	131	10.84	12.11	12.88	14.60	16.43	18.17	20.41
13	INDUSTRY	101	23.32	25.09	25.85	28.72	30.04	33.13	36.16
14	CONSTRUCTION	148	2.08	2.35	2.39	2.76	2.96	3.34	3.79
15	TRANSPORT/COMMUNICATIONS	150	5.97	6.38	6.86	7.56	8.12	9.24	10.38
16	HOUSING	160	11.46	12.24	12.59	13.35	14.05	14.67	15.15
17	SERVICES & TRADE	178	12.37	13.16	13.21	13.85	14.51	15.02	15.36
18									
19	CAPITAL REPAIRS,LEVEL		14.71	15.45	16.54	17.63	18.83	20.11	21.46
20									
21	STATE EXPENDITURES								
22	ADMINISTRATION		1.43	1.45	1.43	1.43	1.44	1.45	1.47
23	SOCIO-CULTURAL,EXCL,SCIENCE		5.15	5.44	5.65	5.94	6.27	6.63	7.02
24	SCIENCE		5.03	5.37	5.73	6.09	6.48	6.85	7.24
25									
26	OFFICIAL DEFENSE EXPENDITURE		14.50	16.70	17.70	17.90	18.09	18.28	18.69
27									
28	INVENTORY CHANGE								
29	DOMESTIC TRADE	1590	2.07	1.79	2.52	3.72	2.66	2.00	2.08
30	NON-TRADE NON-AGRICULTURAL	1580	6.88	3.08	5.53	5.06	6.68	6.77	7.60
31									
32	NET EXPORTS		-3.09	-4.29	-4.21	-3.06	-4.54	-6.92	-7.49
33	TOTAL EXPORTS		13.43	14.43	15.63	17.15	17.98	20.02	22.43
34	TOTAL IMPORTS		16.52	18.72	19.84	21.00	22.53	26.94	29.92
35									
36	OTHER END-USE CATEGORIES	1918	9.46	9.59	9.85	12.61	11.89	9.28	13.22

SRI-WEFA ECONOMETRIC MODEL OF THE USSR
DETENTE CONTROL SOLUTION 1968-73
DATE: FEBRUARY 20,1976

#	DESCRIPTION	MOD. VAR.	LAGGED 1967	FORECAST DATA 1968	1969	1970	1971	1972	1973
1	PERCENT GROWTH IN END-USE CATEG'S								
2									
3	GNP		6.16	5.40	5.86	6.51	4.62	3.53	6.72
4									
5	CONSUMPTION,TOTAL		7.11	6.97	5.22	4.11	5.14	4.11	5.04
6									
7	FOOD		7.04	5.82	3.04	4.74	4.21	4.04	4.47
8	SOFT GOODS		8.44	9.16	6.87	4.02	6.43	4.96	5.93
9	DURABLES		9.38	10.75	9.00	4.14	7.15	4.26	5.67
10	SERVICES		5.34	6.34	7.39	2.80	5.25	3.35	5.15
11									
12	INVESTMENT, TOTAL NEW FIXED		8.33	8.04	3.45	9.54	6.52	8.68	8.20
13									
14	AGRICULTURE		6.76	11.70	6.37	13.40	12.47	10.60	12.35
15	INDUSTRY		6.86	7.63	3.02	11.09	4.59	10.31	9.12
16	CONSTRUCTION		15.32	13.16	1.85	15.23	7.21	12.98	13.42
17	TRANSPORT/COMMUNICATIONS		4.67	6.95	7.58	10.08	7.53	13.69	12.35
18	HOUSING		7.78	8.82	2.89	6.04	5.25	4.41	3.29
19	SERVICES & TRADE		14.08	6.39	0.39	4.78	4.78	3.56	2.22
20									
21	CAPITAL REPAIR		6.15	5.04	7.05	6.58	6.77	6.85	6.71
22									
23	STATE EXPENDITURES		-2.12	5.64	4.49	5.01	5.51	5.23	5.35
24	ADMINISTRATION		-1.27	1.29	-1.57	0.02	0.73	1.03	1.20
25	SOCIO-CULTURAL,EXCL.SCIENCE		-2.26	5.64	3.91	5.07	5.63	5.79	5.83
26	SCIENCE		-2.21	6.07	6.72	6.18	6.50	5.62	5.76
27									
28	OFFICIAL DEFENSE EXPENDITURE		-2.27	15.17	5.99	1.13	1.08	1.04	2.22
29									
30	INVENTORY CHANGE		-28.50	-45.57	65.15	18.98	-2.43	-6.12	10.32
31	DOMESTIC TRADE		128.03	-13.43	40.64	47.50	-28.48	-24.85	3.92
32	NON-TRADE NON-AGRICULTURAL		-40.74	-55.24	79.40	5.97	14.11	1.34	12.20
33									
34	NET EXPORTS								
35	TOTAL EXPORTS		9.17	7.39	8.31	9.73	4.87	11.32	12.04
36	TOTAL IMPORTS		9.05	13.26	5.98	5.88	7.26	19.58	11.09
37									
38	OTHER END-USE CATEGORIES		75.52	1.70	2.69	28.00	-5.68	-21.95	42.51

SRI-WEFA ECONOMETRIC MODEL OF THE USSR
DETENTE CONTROL SOLUTION 1968-73
DATE: FEBRUARY 20,1976

NO	DESCRIPTION	MOD. VAR.	LAGGED 1967	FORECAST DATA 1968	1969	1970	1971	1972	1973
1	TOTAL EXPORTS M.$US	27311	9652.	10473.	11227.	12701.	13987.	16174.	20589.
2	-GROWTH		9.17	8.51	7.20	13.13	10.12	15.64	27.29
3	TOTAL IMPORTS M.$US	29011	8537.	9566.	10469.	11668.	12515.	16000.	21006.
4	-GROWTH		7.89	12.05	9.44	11.46	7.26	27.85	31.28
5	CMEA								
6	EXPORTS,TOTAL	25811	4535.	5045.	5311.	5983.	6607.	7115.	7107.
7	RAW MATERIALS	25481	2492.	2766.	2951.	3152.	3530.	3937.	4015.
8	MACHINERY	25501	996.	1109.	1205.	1287.	1512.	1700.	1931.
9	GRAIN	25601	244.	233.	204.	312.	427.	261.	0.
10	CONSUMPTION GOODS	25781	318.	260.	260.	315.	279.	243.	199.
11									
12	IMPORTS,TOTAL	27911	4583.	5115.	5499.	6021.	6408.	7596.	8238.
13	RAW MATERIALS	27501	705.	739.	767.	775.	827.	833.	904.
14	MACHINERY	27601	1966.	2260.	2378.	2675.	2743.	3387.	3844.
15	FOOD	27701	390.	461.	509.	559.	608.	657.	710.
16	CONSUMPTION GOODS	27801	1090.	1178.	1284.	1369.	1509.	1705.	1764.
17									
18	DEVELOPED WEST								
19	EXPORTS,TOTAL	26311	1886.	2038.	2187.	2402.	2720.	2867.	4566.
20	NON-FOOD	26001	1740.	1914.	2017.	2257.	2566.	2681.	4365.
21	GRAIN	26101	32.	26.	64.	34.	30.	53.	81.
22	OTHER FOOD	26201	114.	98.	106.	111.	135.	132.	121.
23									
24	IMPORTS,TOTAL	28511	1782.	2138.	2461.	2795.	2828.	4076.	6028.
25	MACHINERY	28101	670.	866.	1088.	1154.	1043.	1332.	1647.
26	CONSUMER GOODS	28201	219.	230.	281.	289.	311.	254.	321.
27	RAW MATERIALS	28311	707.	850.	891.	1105.	1147.	1420.	2602.
28	GRAIN	28411	146.	121.	20.	122.	170.	471.	1001.
29									
30	DEVELOPING COUNTRIES								
31	EXPORTS,TOTAL	26611	963.	1006.	1108.	1239.	1413.	1611.	1861.
32									
33	IMPORTS,TOTAL	28601	805.	940.	1099.	1251.	1468.	1774.	2403.
34									
35	OTHER SOCIALIST COUNTRIES								
36	EXPORTS,TOTAL		1338.	1323.	1457.	1617.	1803.	2005.	2318.
37									
38	IMPORTS,TOTAL		853.	780.	780.	923.	1068.	927.	1431.
39									
40	HARD CURRENCY								
41	OUTSTANDING DEBT	32311	658.	978.	1333.	1603.	1913.	2442.	3499.
42	HARD CURRENCY HOLDING	32611	614.	710.	641.	431.	466.	-390.	-310.
43	GOLD RESERVES		1423.	1592.	1992.	2256.	2462.	3607.	5720.
44	LIQUIDITY RATIO	32911	0.4294	0.2873	0.2678	0.2051	0.1939	0.2859	0.3685

APPENDIX B

Major Assumptions: Control Solution 1974-1990

Variable	Description (Units)	1974	1975	1976	1977-1980†	1981-1990†
IFINE9	Financing of Centralized Investment (B. Cur. Rubles)	77.3*	85.4*	88.3*	5.0%	5.0%
IFTRE9	Financing of Transport/Communications (B. Cur. Rubles)	17.6*	18.8*	19.6*	5.0%	5.0%
IFAGE9	Financing of Agriculture (B. Cur. Rubles)	33.0*	37.1*	37.2*	7.0%	5.0%
BDE9	Official Defense Expenditures (B. Cur. Rubles)	17.6*	17.4	17.4	4.0%	4.0%
BDNE9	Nonpersonnel Defense Expenditures (B. Cur. Rubles)	12.5	12.8	13.1	4.0%	4.0%
NPOP9	Total Population (M. Persons)	250.9*	253.3*	255.7	0.95%	0.92%
SAI9	Sown Acreage (Index)	101.	102.	103.	105.	105.
PIWH70	Wholesale Industrial Price (Index)	93.94*	93.94	94.41	0.5%	0.5%
PREX9	Official Exchange Rate ($/Ruble)	1.35*	1.35*	1.35	1.35	1.35
PTM9	Official Import Price Index	110.	121.	133.	6.%	3.%
PTX9	Official Export Price Index	119.	131.	138.	5.%	3.%
PGOLD9	Gold Price (Index)	3.35*	2.51	2.24	2.24	2.24

Major Assumptions: Control Solution 1974-1990

Variable	Description (Units)	1974	1975	1976	1977-1980†	1981-1990†
PGR9	Grain Price (Index)	268.*	246.	268.	2.%	2.%
FCDR$9	Hard Currency Credit Drawings (M. Cur. $)	1700.	3000.	3500.	1500.	1.%
FGSALE$	Gold Sales (M. Cur. $)	750.	1000.	700.	700.	300.
MGRDW$	Grain Imports from Developed West (M. Cur. $)	500.	1000.	3000.	1000.	1000.
PERMCM9	Raw Materials Export Price to CMEA (Index)	68.9	97.5	102.5	5.%	3.%
YCMEA9	Net Material Product in CMEA (Index)	194.8*	205.5	218.	6.5%	6.%
PRMW9	World Raw Materials Price (Index)	295.*	292.*	292.	3.%	3.%
PTW9	Price Index, World Trade	216.*	231.*	248.	7.%	5.%
XGOLD9	Soviet Production of Gold (Metric Tons)	228.	233.	238.	3.%	3.%
P599	U.S. Import Deflator, Manufactures	197.*	226.	242.	7.%	5.%
PENFDW9	Non-Food Export Deflator, to the Developed West	223.	245.	245.	7.%	5.%

Major Assumptions: Control Solution 1974-1990

Variable	Description (Units)	1974	1975	1976	1977-1980†	1981-1990†
WTDW9	Trade Activity, Developed West	290.*	287.	304.	7.%	7.%
PMAW9	World Machinery Price Index	187.*	200.	214.	7.%	5.%
WTLDC9	Trade Activity, LDC's	7480.*	7480.	7930.	7.%	7.%
WT9	Trade Activity, World	270.*	276.	294.	7.%	7.%
PNRMCM9	Raw Material Import Price, from CMEA	104.3	112.	112.	5.%	3.%
P71GE9	Non-Electrical Machinery Price, West German Exports	153.*	169.	179.	7.%	5.%

---

* Actual data

† Annual growth rate per year unless otherwise specified.

APPENDIX C

SRI-WEFA ECONOMETRIC MODEL OF THE USA
CONTROL I THROUGH 1980 - CONSUMPTION BY RESIDUAL
DATE: MARCH 9, 1976

#	DESCRIPTION	MOD. VAR.	LAGGED 1972	1973	1974	FORECAST DATA 1975	1976	1977	1978	1979	1980
1	GNP-SECTOR-OF-ORIGIN-B.1970R	9611	387.061	413.97	432.53	445.69	469.01	492.94	514.68	537.71	559.16
2	PERCENTAGE GROWTH IN GNP		3.201	6.73	4.48	3.04	5.23	5.10	4.41	4.47	3.99
3	GNP PER CAPITA, 1970 RB/PERSON		1560.191	1649.96	1707.70	1743.07	1817.01	1891.77	1956.56	2024.67	2085.86
4	GROWTH IN GNP PER CAPITA		2.241	5.75	3.50	2.07	4.24	4.11	3.43	3.49	3.01
5	GNP-SECTOR-OF-ORIGIN-B.1970R										
6											
7	AGRICULTURE	9571	53.751	63.19	60.12	52.32	59.29	59.45	59.38	61.63	60.62
8	-GROWTH		-9.841	17.54	-4.84	-12.97	13.31	0.28	-0.12	3.79	-1.63
9											
10	INDUSTRY		197.831	209.13	223.47	236.56	247.64	265.33	280.51	295.67	311.86
11	-GROWTH-TOTAL		5.661	5.72	6.85	5.86	4.77	7.06	5.72	5.41	5.48
12	-GROWTH-BY BRANCH										
13	ELECTROENERGY		7.111	5.65	4.93	6.19	5.38	4.19	3.93	3.90	4.84
14	COAL PRODUCTS		2.141	0.59	1.95	1.68	1.47	1.52	1.31	1.26	1.53
15	PETROLEUM PRODUCTS		7.261	7.36	6.99	6.33	6.34	6.44	6.94	6.72	6.49
16	FERROUS METALLURGY		3.621	2.43	4.07	3.90	3.68	3.56	3.66	4.00	4.19
17	NON-FERROUS METALLURGY		4.941	8.69	6.65	4.91	6.39	4.63	5.85	6.05	5.55
18	CONSTRUCTION MATERIALS		4.641	4.48	5.50	8.01	4.53	5.92	6.80	7.22	7.32
19	CHEMICALS & PETROCHEMICALS		6.951	1.36	8.13	7.27	5.56	4.35	7.11	7.41	5.28
20	MACH.BLDG.& METAL-WORKING		7.721	7.28	6.65	6.58	6.15	5.84	5.76	5.65	5.99
21	FOREST PRODUCTS		3.271	0.77	2.95	0.84	2.59	2.97	2.52	2.72	3.09
22	PAPER & PULP		4.501	6.36	6.94	6.55	4.72	5.05	5.57	5.58	5.48
23	SOFT GOODS		0.581	-0.04	6.72	4.52	-0.43	5.92	3.30	3.32	4.33
24	PROCESSED FOODS		3.531	1.31	6.89	2.55	0.31	4.89	3.20	3.09	3.61
25											
26	CONSTRUCTION		30.451	31.14	32.60	34.31	35.01	35.46	35.40	35.15	35.34
27	-GROWTH		6.721	2.27	4.66	5.26	2.04	1.30	-0.17	-0.72	0.54
28											
29	TRANSPORT/COMMUNICATION		39.011	42.54	45.32	48.37	50.51	54.11	58.28	61.94	65.75
30	-GROWTH		6.331	8.55	7.03	6.74	4.42	7.13	7.69	6.29	6.14
31											
32	DOMESTIC TRADE		19.531	19.51	20.27	21.57	22.08	22.85	24.08	25.07	26.20
33	-GROWTH		6.881	-1.08	4.96	6.41	2.34	3.51	5.37	4.12	4.52
34											
35	SERVICES/GOVERNMENT		47.311	48.86	50.76	52.55	54.29	55.73	57.04	58.25	59.39
36	-GROWTH		3.951	3.28	3.87	3.54	3.31	2.66	2.34	2.12	1.96
37											
38	NET MATERIAL PRODUCT-B.1970R		340.551	365.11	381.77	393.13	414.72	437.20	457.64	479.46	499.47
39	PERCENTAGE GROWTH IN NMP		3.101	7.21	4.56	2.98	5.49	5.42	4.67	4.77	4.24
40	GRAIN OUTPUT-M.TONS	3378	108.451	144.42	127.86	91.06	141.76	146.80	149.96	153.17	155.80
41	GROWTH IN GRAIN OUTPUT		-12.151	33.17	-11.47	-28.76	55.64	3.56	2.15	2.14	1.72
42	SHARES OF SECTORS IN GNP										
43	AGRICULTURE		0.141	0.15	0.14	0.12	0.13	0.12	0.12	0.11	0.11
44	INDUSTRY		0.511	0.51	0.52	0.53	0.53	0.54	0.55	0.55	0.56
45	CONSTRUCTION		0.081	0.08	0.08	0.08	0.07	0.07	0.07	0.07	0.06
46	TRANSPORT/COMMUNICATION		0.101	0.10	0.10	0.11	0.11	0.11	0.11	0.12	0.12
47	DOMESTIC TRADE		0.051	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
48	SERVICES/GOVERNMENT		0.121	0.12	0.12	0.12	0.12	0.11	0.11	0.11	0.11

SRI-WEFA ECONOMETRIC MODEL OF THE USSR
CONTROL I THROUGH 1980 - CONSUMPTION BY RESIDUAL
DATE: MARCH 9, 1976

#	DESCRIPTION	MOD. VAR.	LAGGED 1972	1973	1974	FORECAST DATA 1975	1976	1977	1978	1979	1980
1	GNP,END-USE,B.1970R		387.86	413.97	432.57	445.69	469.00	492.94	514.68	537.71	559.16
2	GROWTH IN END-USE GNP		3.20	6.73	4.49	3.03	5.23	5.11	4.41	4.47	3.99
3	CONSUMPTION,TOTAL	134I	227.49	244.46	258.17	267.37	282.90	289.04	303.63	318.36	330.32
4											
5	FOOD	135R	108.15	116.87	123.51	126.24	132.95	136.60	140.68	145.69	148.14
6	SOFT GOODS	136R	53.22	56.80	60.32	63.28	67.21	68.95	72.95	76.45	79.27
7	DURABLES	137R	16.11	17.44	18.73	19.84	21.11	21.09	23.61	25.72	28.22
8	SERVICES	138R	50.01	53.35	55.61	58.01	61.64	62.34	66.40	70.51	74.70
9											
10	INVESTMENT,TOTAL NEW FIXED	191	94.26	98.32	105.12	110.51	114.65	122.21	129.72	136.34	142.97
11											
12	AGRICULTURE	13R	18.10	19.98	21.76	23.06	23.94	25.33	26.67	28.10	29.49
13	INDUSTRY	1R	33.09	34.92	37.63	41.24	44.37	47.73	51.27	55.04	59.03
14	CONSTRUCTION	14R	3.60	3.67	3.90	3.99	4.05	4.44	4.80	4.96	5.08
15	TRANSPORT/COMMUNICATIONS	15R	9.62	10.45	10.61	11.17	11.74	12.67	13.66	14.31	14.98
16	HOUSING	16R	14.63	15.12	15.58	16.10	16.64	17.18	17.74	18.33	18.93
17	SERVICES & TRADE	17R	15.22	14.58	15.65	14.95	13.91	14.87	15.56	15.60	15.46
18											
19	CAPITAL REPAIRS,LEVEL		19.74	21.46	22.91	24.42	25.96	27.50	29.08	30.74	32.44
20											
21	STATE EXPENDITURES										
22	ADMINISTRATION		1.45	1.47	1.45	1.46	1.46	1.45	1.43	1.42	1.40
23	SOCIO-CULTURAL,EXCL.SCIENCE		6.37	6.75	6.96	7.28	7.50	7.60	7.75	7.88	7.96
24	SCIENCE		6.94	7.39	7.64	7.94	8.22	8.45	8.71	8.96	9.19
25											
26	OFFICIAL DEFENSE EXPENDITURE		18.28	18.69	18.41	18.23	18.18	18.83	19.51	20.21	20.94
27											
28	INVENTORY CHANGE										
29	DOMESTIC TRADE	159R	1.41	2.10	1.70	1.59	2.09	2.63	1.28	1.46	1.40
30	NON-TRADE NON-AGRICULTURAL	158R	11.10	8.92	7.31	7.97	6.23	9.34	9.15	8.67	9.08
31											
32	NET EXPORTS		-8.03	-8.84	-10.03	-13.28	-12.37	-8.31	-7.80	-7.79	-8.00
33	TOTAL EXPORTS		19.08	21.44	22.10	23.40	24.75	26.67	28.77	31.09	33.50
34	TOTAL IMPORTS		27.11	30.28	32.13	36.68	37.12	34.98	36.57	38.87	41.50
35											
36	OTHER END-USE CATEGORIES	191R	8.45	13.24	12.92	12.21	14.18	13.40	12.22	11.47	11.47

SRI-WEFA ECONOMETRIC MODEL OF THE USSR
CONTROL I THROUGH 1980 - CONSUMPTION BY RESIDUAL
DATE: MARCH 9, 1976

#	DESCRIPTION	MOD. VAR.	LAGGED 1972	1973	1974	FORECAST DATA 1975	1976	1977	1978	1979	1980
1	PERCENT GROWTH IN END-USE CATEG'S										
2											
3	GNP		3.20	6.73	4.49	3.03	5.23	5.11	4.41	4.47	3.99
4											
5	CONSUMPTION,TOTAL		3.74	7.46	5.61	3.56	5.81	2.45	4.76	4.85	3.76
6											
7	FOOD		2.09	8.06	5.69	2.21	5.31	2.80	2.93	3.56	1.68
8	SOFT GOODS		5.47	6.73	6.20	4.91	6.21	2.58	5.81	4.79	3.70
9	DURABLES		5.90	8.29	7.38	5.94	6.37	3.70	7.89	8.93	9.72
10	SERVICES		4.88	6.70	4.22	4.32	6.26	1.13	6.52	6.19	5.94
11											
12	INVESTMENT, TOTAL NEW FIXED		7.14	4.31	6.92	5.12	3.75	6.59	6.15	5.11	4.86
13											
14	AGRICULTURE		9.49	10.43	8.88	5.99	3.83	5.79	5.30	5.35	4.94
15	INDUSTRY		7.14	5.31	7.77	9.50	7.60	7.56	7.42	7.36	7.24
16	CONSTRUCTION		6.29	2.06	6.24	2.14	1.62	9.60	8.23	3.25	2.46
17	TRANSPORT/COMMUNICATIONS		13.46	4.50	5.52	5.36	5.07	7.88	7.88	4.72	4.72
18	HOUSING		3.82	3.29	3.06	3.33	3.36	3.27	3.27	3.27	3.27
19	SERVICES & TRADE		4.19	-4.21	7.32	-4.44	-6.97	6.87	4.70	0.26	-0.85
20											
21	CAPITAL REPAIR		5.00	8.74	6.76	6.58	6.29	5.94	5.75	5.70	5.55
22											
23	STATE EXPENDITURES		4.14	5.83	2.76	3.86	3.06	1.89	2.19	2.09	1.60
24	ADMINISTRATION		-2.76	1.31	-1.30	0.38	0.43	-1.20	-0.83	-0.98	-1.67
25	SOCIO-CULTURAL,EXCL.SCIENCE		4.07	6.82	3.02	4.56	3.05	1.42	1.85	1.73	1.07
26	SCIENCE		5.79	6.59	3.33	3.89	3.54	2.86	3.00	2.92	2.59
27											
28	OFFICIAL DEFENSE EXPENDITURE		1.04	2.22	-1.50	-0.98	-0.27	3.60	3.61	3.61	3.61
29											
30	INVENTORY CHANGE		11.13	-11.91	-10.22	6.16	-13.01	43.80	-12.85	-2.92	3.52
31	DOMESTIC TRADE		-45.90	48.67	-19.02	-6.09	30.96	25.80	-51.29	14.00	-4.23
32	NON-TRADE NON-AGRICULTURAL		20.37	-19.61	-10.03	9.00	-21.80	49.81	-2.04	-5.28	4.82
33											
34	NET EXPORTS		70.49	10.98	13.37	32.49	-6.89	-32.83	-6.16	-0.11	2.73
35	TOTAL EXPORTS		7.47	12.56	3.11	5.87	5.78	7.74	7.89	8.03	7.77
36	TOTAL IMPORTS		20.69	11.68	6.11	14.18	1.19	-5.78	4.55	6.30	6.76
37											
38	OTHER END-USE CATEGORIES		-22.89	56.65	-2.40	-5.46	16.11	-5.48	-8.81	-6.20	0.00

SRI-WEFA ECONOMETRIC MODEL OF THE USSR
CONTROL I THROUGH 1980 - CONSUMPTION BY RESIDUAL
DATE: MARCH 9, 1976

#	DESCRIPTION	MOD. VAR.	LAGGED 1972	1973	1974	FORECAST DATA 1975	1976	1977	1978	1979	1980
1	TOTAL EXPORTS TH.$US	2731	15916.	21419.	23673.	27590.	30744.	34779.	39400.	44693.	50676.
2	-GROWTH		11.66	30.91	10.54	16.55	11.43	13.13	13.28	13.44	13.36
3	TOTAL IMPORTS TH.$US	2901	16105.	20846.	23856.	29962.	33326.	33205.	36888.	41564.	47057.
4	-GROWTH		29.06	29.45	14.43	25.59	11.23	-0.12	10.83	12.67	13.17
5	CMEA										
6	EXPORTS,TOTAL	2501	6727.	7361.	7963.	9729.	10691.	12034.	13557.	15314.	17213.
7	RAW MATERIALS	2541	3715.	3919.	4360.	5538.	6133.	6871.	7744.	8724.	9823.
8	MACHINERY	2551	1689.	1969.	2158.	2934.	3326.	3812.	4307.	5032.	5755.
9	GRAIN	2561	204.	201.	202.	0.	0.	0.	0.	55.	31.
10	CONSUMPTION GOODS	2571	224.	238.	242.	206.	132.	175.	167.	156.	162.
11											
12	IMPORTS,TOTAL	2791	7687.	7990.	8952.	10742.	12141.	13382.	14710.	16449.	18517.
13	RAW MATERIALS	2751	897.	897.	950.	1175.	1293.	1445.	1508.	1615.	1802.
14	MACHINERY	2761	3395.	3679.	4453.	5091.	6986.	7980.	9084.	10458.	12004.
15	FOOD	2771	663.	717.	783.	827.	890.	940.	987.	1040.	1077.
16	CONSUMPTION GOODS	2781	1710.	1682.	1767.	1799.	1871.	1861.	1926.	2063.	2217.
17											
18	DEVELOPED WEST										
19	EXPORTS,TOTAL	2631	2084.	5060.	6805.	7742.	8885.	10507.	12408.	14607.	17144.
20	NON-FOOD	2601	2770.	4939.	6655.	7600.	8769.	10363.	12260.	14456.	16980.
21	GRAIN	2611	2.	1.	0.	0.	0.	0.	0.	0.	0.
22	OTHER FOOD	2621	104.	131.	150.	142.	116.	144.	148.	152.	165.
23											
24	IMPORTS,TOTAL	2851	4097.	6131.	6993.	10722.	12126.	10312.	11877.	13932.	16290.
25	MACHINERY	2811	1368.	2076.	2491.	3912.	5392.	3795.	4494.	5367.	6361.
26	CONSUMER GOODS	2821	285.	646.	829.	1227.	1150.	1171.	1652.	2176.	2619.
27	RAW MATERIALS	2831	1354.	1952.	2479.	3983.	4083.	3831.	4202.	4843.	5547.
28	GRAIN	2841	471.	1001.	500.	1000.	3000.	1000.	1000.	1000.	1000.
29											
30	DEVELOPING COUNTRIES										
31	EXPORTS,TOTAL	2661	1426.	1928.	2115.	2170.	2296.	2455.	2635.	2832.	3045.
32											
33	IMPORTS,TOTAL	2861	1669.	2391.	3160.	2957.	2936.	3047.	3217.	3435.	3692.
34											
35	OTHER SOCIALIST COUNTRIES										
36	EXPORTS,TOTAL		1880.	2341.	2603.	2735.	2930.	3152.	3393.	3651.	3929.
37											
38	IMPORTS,TOTAL		1007.	1517.	1600.	1751.	1775.	1810.	1874.	1940.	2008.
39											
40	HARD CURRENCY										
41	OUTSTANDING DEBT	3231	2583.	3616.	4391.	6280.	8176.	7594.	7251.	7071.	7002.
42	HARD CURRENCY HOLDING	3261	-43.	227.	1237.	145.	-1691.	-1038.	-1314.	-837.	774.
43	GOLD RESERVES		3607.	5720.	6211.	4239.	3616.	3465.	3331.	3213.	3115.
44	LIQUIDITY RATIO	3291	0.2501	0.3452	0.2683	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000